Rapid Assessment Program

14

RAP Bulletin of Biological Assessment

A Biological Assessment of the Wapoga River Area of Northwestern Irian Jaya, Indonesia

Andrew L. Mack and Leeanne E. Alonso, Editors

CENTER FOR APPLIED BIODIVERSITY SCIENCE (CABS)
CONSERVATION INTERNATIONAL
INDONESIAN NATIONAL INSTITUTE OF SCIENCES (LIPI)
BANDUNG TECHNOLOGY INSTITUTE (ITB)
UNIVERSITY OF CENDERAWASIH (UNCEN)
PERLINDUNGAN DAN KONSERVASI ALAM (PKA)
BADAN PENGEMBANGAN DAN PEMBANGUNAN DAERAH (BAPPEDA)

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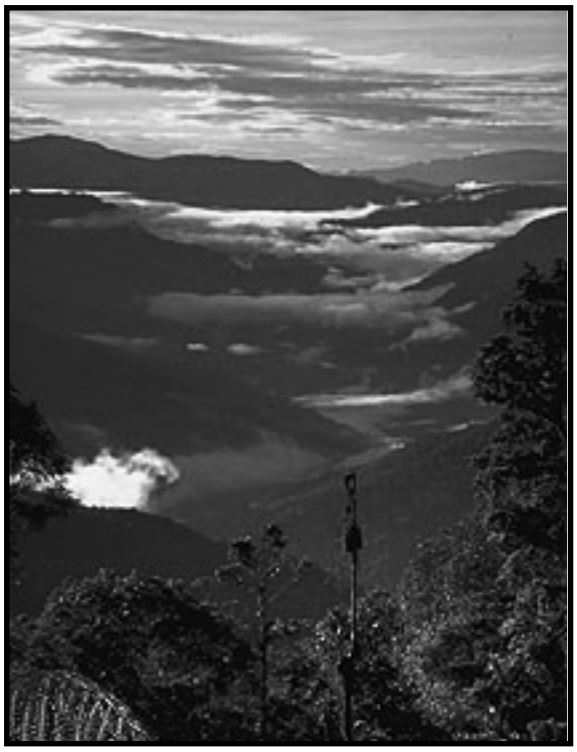

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ORGANIZATIONAL PROFILES

CONSERVATION INTERNATIONAL

Conservation International (CI) is an international, non-profit organization based in Washington, D.C. CI acts on the belief that the Earth's natural heritage must be maintained if future generations are to thrive spiritually, culturally, and economically. Our mission is to conserve biological diversity and the ecological processes that support life on earth and to demonstrate that human societies are able to live harmoniously with nature.

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CONSERVATION INTERNATIONAL - IRIAN JAYA

CI-Irian Jaya was formally established in 1995, after a CI analysis designated the island of New Guinea as a key Major Tropical Wilderness area. CI's long term goal in Irian Jaya is to promote people-based nature conservation and sustainable economic development through the sustainable use of Irian Jaya's resources. The strategy for the province is based on the recognition that Irian Jaya still has large, virtually unexplored areas of high biodiversity that are globally significant and should be targeted for in-depth scientific study. To help meet the conservation and development needs of the province, CI is pursuing a long term strategy to assist Indonesian institutions and NGOs in tackling the challenge of designing and implementing conservation and sustainable development initiatives in Irian Jaya.

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CONSERVATION INTERNATIONAL - INDONESIA

CI-Indonesia was founded in 1992 to protect and conserve biodiversity in the hotspot regions of Indonesia that include the Eastern Sundaic Region covering East Nusa Tenggara, West Nusa Tenggara, Sulawesi, and Maluku; and the Western Sundaic Region that includes Sumatera, Jawa, Kalimantan, Bali, and Lombok Island. The Tropical Wilderness Area of Irian Jaya is also a focus of the program. CI-Indonesia's approach is to offer technical support to Indonesian institutions and to facilitate the establishment of long-term field projects that promote community-based conservation and sustainable development. CI also emphasizes the scientific assessment of biodiversity and the documentation of economic, cultural and social importance of biodiversity for Indonesia people. Through collaborations with many Indonesian institutions, CI facilitates discussion among stakeholders, both at national, regional, and local levels to make strategic decisions regarding where protected areas should be located and to come to an understanding of the importance of conserving biodiversity in Indonesia.

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INDONESIAN INSTITUTE OF SCIENCES (LIPI)

The Indonesian Institute of Sciences (LIPI) is a non-departmental institution that reports directly to the President of Indonesia. The main tasks of LIPI are to assist the President in organizing research and development, and to provide guidance, services, and advice to the government on national science and technology policy. In order to accomplish its main tasks, LIPI was assigned the following functions:

1. To carry out research and development of science and technology.
2. To encourage and develop science consciousness among the Indonesian people.
3. To develop and improve cooperation with national as well as international scientific bodies in accordance with the existing laws and regulations.
4. To provide the government with the formulation of national science policy.

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PERLINDUNGAN DAN KONSERVASI ALAMB (PKA)

Perlindungan dan Konservasi Alam (PKA) Direktorat Jenderal PKA (Perlindungan dan Konservasi Alam) (formerly PHPA/Perlindungan Hutan dan Pelestarian Alam) is a directorate general under the Ministry of Forestry responsible for managing the conservation area system. Two sub-directorate are concerned specifically with conservation issues: (1) The Directorate of Sanctuary Reserve Mangement and Conservation of Flora and Fauna (BKSFF), responsible for planning the protected area system, drafting conservation legislation, and proposing, establishing and managing individual protected areas; (2) the Directorate of National Park and Recreation Forest, which deals with national parks and recreation parks programs.

Direktorat Jenderal PKA
Manggala Wanabakti Jl. Gatot Subroto
Jakarta

BANDUNG TECHNOLOGY INSTITUTE (ITB)

Bandung Technology Institute (ITB), located in Bandung, capital of West Java, is regarded as one of the oldest and most prestigious technology institutes in Indonesia. Founded in 1920, ITB was established by Engineering Faculty of the University of Indonesia. ITB's mission is to enhance the technological expertise of Indonesia and to develop applicable technology for its people. ITB has recently emphasized the importance of integrating human interests with technology.

ITB
Jl. Ganesha 10
Bandung 40132, Indonesia

UNIVERSITY OF CENDERAWASIH (UNCEN)

University of Cenderawasih is the only state university in the province of Irian Jaya. It serves as the center of excellence for Irianese students. UNCEN's mission has been to train and enhance the technological and human resources of Irian Jaya to the benefit of the Irianese people and community. Focus has been on agriculture, economics, and fisheries.

BADAN PENGEMBANGAN DAN PEMBANGUNAN DAERAH (BAPPEDA)

BAPPEDA is a governmental agency which acts at the provincial and district levels to carry out regional development planning in Irian Jaya.

BAPPEDA Dati I Irian Jaya
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REPORT AT GLANCE

Report of a rapid biological assessment (RAP) of the Wapoga River Area, northwestern Irian Jaya, Indonesia

1) Dates of Expedition: 31 March – 2 May, 1998

2) The Importance of RAP in Irian Jaya:
Irian Jaya, located in the eastern part of Indonesia territory with a total area of 416,000 km^2, may contribute up to 50% of Indonesian biodiversity. However, there is a lack of comprehensive multi-disciplinary research that explores and describes the biological resources of Irian Jaya. Conservation International seeks to fill this gap by conducting a series of rapid biological assessments in Irian Jaya.

3) Description of Expedition Location:
The RAP expedition surveyed five sites in the vicinity of the Siewa and Wapoga Rivers (designated as the Wapoga River Area of northwestern Irian Jaya in this report), in the District of Paniai which lies between 3° 02.202' S, 136° 22. 515' E and 3° 08.687' S, 136° 33.412' E. Surveys were conducted in a diversity of habitat types (lowland forest to high cloud forest) at a range of elevations from sea level up to 1890 m above sea level.

4) Reason for RAP expedition:
The Wapoga River Area was chosen because it was identified in the CI sponsored Irian Jaya Biodiversity Conservation Priority-Setting Workshop (1997) as an area where ecological and biogeographic data are particularly inadequate. One goal of the survey was to provide data on the biota of an area that has remained virtually unexplored by biologists. Results from the RAP expedition provide scientific information on the rich diversity of the terrestrial and freshwater aquatic flora and fauna of this area. This information may be used by policy makers, conservationists, researchers, NGOs, and local people to integrate their conservation and development activities.

5) Major Results:
The Wapoga River Area is a large area of pristine forest, with very little evidence of human disturbance. Few such areas remain in New Guinea or throughout the world's tropical areas. RAP scientists discovered many new species of frogs, aquatic insects, ants, fishes, lizards and plants, highlighting the importance of this area for biodiversity conservation and illustrating our limited knowledge of the flora and fauna of Irian Jaya. Numerous range extensions and new records for Irian Jaya were found among aquatic insects, ants, frogs, and birds. Strong populations of several frog species that are in decline in other parts of the world were found during the RAP survey. The unique species composition of the Wapoga River Area suggests that the area straddles the boundary of two biogeographical sub-provinces and as such may constitute a unique zoogeographical zone.

Species recorded:	
Plants	> 430 species
Aquatic Insects:	
Heteroptera (true bugs)	80 species (34 genera)
Zygoptera (dragonflies and damselflies)	25 species (12 genera)
Ants	196 species (52 genera)
Fishes	46 species
Frogs	47 species
Reptiles (lizards, turtles, geckos, snakes)	25 species
Birds	213 species
Mammals	11 species

6) New species discovered:

Plants	5 species
Aquatic Insects:	
Heteroptera (true bugs)	36 species, 2 genera
Zygoptera (dragonflies and damselflies)	2 species
Ants	17 species
Fishes	3 species, including two rainbowfishes and one goby
Frogs	29 species (>50%)
Reptiles (lizards and geckos)	2 species

6) Recommendations and Conservation Activities:
We trust that this RAP expedition will serve as a model for future collaborations between industry and conservation/ academic institutions. The pristine nature of the Wapoga River Area makes it an ideal location for future studies. Much more research is needed on all taxonomic groups to complete our knowledge of the high diversity of the Wapoga River Area and to determine the types of conservation activities needed to preserve its unique biota. Efforts should be made to limit human impacts and prevent the introduction of exotic species into the area. RAP herpetologists recommend future monitoring of several frog populations to provide insight into the potential causes and solutions of their decline in other parts of the world.

LAPORAN RINGKAS

Laporan Penilaian Cepat Kondisi Biologi di Kawasan Sungai Wapoga, Irian Jaya, Indonesia.

1) Tanggal Ekspedisi:
31 Maret – 2 Mei 1998

2) Pentingnya RAP di Irian Jaya:
Irian Jaya yang terletak di ujung timur Indonesia dengan total wilayah daratan seluas 416.000 km2, ternyata menyumbang 30% hingga 50 % dari total keanekaragaman hayati Indonesia. Namun penelitian multi-disiplin yang komprehensifuntuk mengungkap kekayaan hayatinya belum banyak dilakukan. Salah satu usaha yang telah dilakukan oleh CI untuk mengisi kekurangan informasi tersebut adalah dengan melakukan serangkaian survei RAP (*Rapid Assessment Program*) di Irian Jaya.

3) Deskripsi Lokasi:
Ekspedisi RAP dilakukan di Seiwa dan Wapoga (Kawasan Sungai Wapoga, barat laut Irian Jaya), Kabupaten Paniai, yang terletak antara 3° 02.202' LS, 136° 22. 515' BT dan 3° 08.687' LS, 136° 33.412' BT. Survei dilakukan pada berbagai tipe habitat, mulai dari hutan dataran rendah sampai hutan kabut pegunungan dengan ketinggian mulai dari pantai hingga 1890 m di atas permukaan laut.

4) Alasan Pelaksanaan Ekspedisi RAP:
Kawasan Sungai Wapoga dipilih sebagai tempat ekspedisi karena dari Lokakarya Penentuan Prioritas Kawasan Konservasi Irian Jaya (1997) yang disponsori Conservation International diketahui bahwa data ekologi dan biogeografi daerah itu sangat tidak memadai. Salah satu tujuan survei adalah menghimpun data keanekaragaman hayati serta potensinya yang selama ini belum pernah diteliti para ahli biologi. Hasil ekspedisi RAP akan memberikan informasi ilmiah tentang kekayaan biota daratan dan perairan Kawasan Sungai Wapoga. Data tersebut diperlukan oleh para pengambil kebijakan, praktisi konservasi, ilmuwan, LSM, dan masyarakat setempat sehingga pembangunan dan konservasi dapat dikerjakan secara terpadu.

5) Hasil-hasil Utama:
Kawasan Sungai Wapoga merupakan daerah hutan perawan yang luas dan hampir tidak tersentuh gangguan manusia. Hanya sedikit daerah seperti itu yang masih tersisa di Irian atau bahkan di seluruh kawasan tropik dunia. Para ilmuwan yang ikut dalam ekspedisi RAP menemukan banyak spesies baru dari kelompok katak, serangga air, semut, ikan, kadal, dan tumbuhan. Penemuan tersebut menunjukkan pentingnya kawasan ini bagi konservasi keanekaragaman hayati, sekaligus menggambarkan keterbatasan pengetahuan kita tentang flora dan fauna Irian Jaya. Banyak serangga air, semut, katak, dan burung ternyata mempunyai sebaran geografis lebih luas dari yang diperkirakan. Selama survei RAP ditemukan populasi yang cukup besar dari beberapa spesies katak yang telah mengalami penyusutan di bagian lain dunia. Keunikan komposisi spesies dalam Kawasan Sungai Wapoga mengindikasikan bahwa daerah tersebut membentang sepanjang perbatasan dua sub propinsi biogeografi dan mungkin merupakan sebuah zona zoogeografi tersendiri.

Tumbuhan	> 430 spesies
Serangga air:	
Heteroptera (kepik sejati)	80 spesies (34 genera)
Zygoptera (capung dan lalat sehari)	25 spesies (12 genera)
Semut	196 spesies (52 genera)
Ikan	46 spesies
Katak	47 spesies
Reptilia (kadal, kura-kura, tokek, ular)	25 spesies

Burung	213 spesies
Mamalia	11 spesies

6) Spesies Baru yang Ditemukan:

Tumbuhan	5 spesies
Serangga air	
Heteroptera (kepik sejati)	36 spesies, 2 genera
Zygoptera (capung dan damselflies)	2 spesies
Semut	17 spesies
Ikan	3 spesies, termasuk 2 ikan penlangi dan 1 ikan gobi
Katak	29 spesies (> 50%)
Reptilia (kadal dan tokek)	2 spesies

7) Rekomendasi dan Upaya Konservasi:

Kami yakin bahwa ekspedisi RAP ini akan berfungsi sebagai sebuah model kerjasama antara industri dan lembaga konservasi akademik di masa yang akan datang. Kondisi alamiah Kawasan Sungai Wapoga yang masih murni menjadikannya sebagai lokasi ideal untuk penelitian-penelitian selanjutnya. Banyak penelitian pada semua kelompok taksonomi yang masih perlu dilakukan untuk melengkapi pengetahuan kita tentang keanekaragaman Kawasan Sungai Wapoga yang sangat tinggi dan untuk menentukan jenis aktivitas konservasi yang diperlukan bagi pelestarian biotanya yang unik. Upaya-upaya yang harus dilakukan mencakup pembatasan dampak kegiatan manusia dan pencegahan introduksi spesies-spesies eksotik ke dalam kawasan. Para ahli herpetologi yang tergabung ke dalam ekspedisi RAP merekomendasikan perlunya kegiatan monitoring bagi beberapa populasi katak untuk mengetahui faktor-faktor yang berpotensi menyebabkan penurunan populasi katak itu di bagian lain dunia dan pada saat yang sama juga memberikan pemecahan terhadap masalah tersebut.

EXECUTIVE SUMMARY

INTRODUCTION

Irian Jaya, with an area of 416,000 km^2, is located on the western part of the island of New Guinea. The combination of high levels of biodiversity and endemism with low human population density (2-6 persons/km^2) led Conservation International in 1997 to declare New Guinea as the only "*Major Tropical Wilderness Area*" remaining in Asia.

The great diversity of this island stems from high speciation that has occurred due to New Guinea's isolation as an island, as well as its rugged terrain. Travel in New Guinea is so difficult that the indigenous people have evolved over 1000 languages in just 50,000 years of occupation.

In comparison to Papua New Guinea (PNG), which makes up the other half of the island (475,369 km^2), the biodiversity of Irian Jaya is poorly known. For instance, up to 510 species of amphibians and reptiles have been documented in PNG compared to 330 species reported for Irian Jaya. The mammal fauna of Irian Jaya is particularly poorly known, with only 164 species reported, in comparison to 227 for PNG.

Considering the current socio-political situation in Irian Jaya, development in many different sectors is needed and cannot be avoided. The Irian Jaya Planning Bureau (Bappeda Irian Jaya) plans economic growth of up to 10% per annum, with concomitant impacts upon the land-use system in the province. Therefore, inventories of biodiversity resources in Irian Jaya are essential in order to support integrated planning in development and conservation. The Wapoga River Area of northwestern Irian Jaya was chosen for this RAP survey because it was identified as an area where ecological and biogeographic data are particularly inadequate. The Irian Jaya Biodiversity Conservation Priority-Setting Workshop, conducted in Biak in early 1997, set priorities for conservation within the province, and highlighted areas, such as the Wapoga area, where there are insufficient data to even begin setting priorities. While the ruggedness of this area has prohibited large-scale land or forest destruction, it has also impeded biological study of the flora and fauna. Development in the form of transmigration, logging, road building, and mining is now growing at an unprecedented rate throughout Irian Jaya and this area. Biological surveys and subsequent conservation actions are urgently needed.

Conservation International (CI) and the Indonesian Institute of Sciences (LIPI) undertook a biological survey from 31 March to 2 May 1998. CI's Rapid Assessment Program (RAP) has conducted 28 terrestrial, freshwater aquatic, and marine RAP surveys in 14 countries around the world, including the Philippine Islands, Papua New Guinea and the Solomon Islands. RAP surveys are designed to quickly gather biological data that can be useful for conservation planning. This was the first RAP survey in Indonesia. The RAP survey was carried out by a team of thirteen scientists from Indonesia (6), United States (4), Australia (2) and England (1). During the RAP expedition, the team surveyed vegetation (trees and understory vegetation), aquatic insects, ants, fishes, amphibians and reptiles, birds, and mammals. Each taxon was surveyed using sampling methodology that would yield the most information in the shortest period of time because visits to survey localities were sometimes limited to just a few days (see Appendix 1 for sampling timeline).

The principal goals of this RAP expedition were to survey an area that had been virtually unexplored by biologists and to use the data collected to enhance conservation planning in Irian Jaya. We trust that this survey will serve as a model for future collaborations in scientific exploration among diverse participants including conservationists, scientists, private industry, and governmental organizations.

Most of the RAP survey was conducted within the Wapoga River drainage, in northwestern Irian Jaya (see

Map 2). The Wapoga River drainage is the second largest drainage in northern Irian Jaya (after the Mamberamo). The terminal reaches of the Wapoga River are commingled with those of the Derewo River. Since a portion of the Derewo also flows to an independent terminus, the systems are generally considered as separate entities. Therefore, in this report, we consider our sampling sites as pertaining to two drainages; four sampling sites were located in the Wapoga River Basin (Map 3), while one site (Helipad 55) was located in the Derewo River Basin. Although some previous logging activity has occurred, most sections of the areas studied during the course of this survey were in pristine and intact condition. The five RAP sampling sites surveyed were: Lower Wapoga River and the Wapoga Staging Area (10 m above sea level), Siewa Base Camp (80 m), Logari/Landing Site 21 (275 m), Wapoga Alpha Camp (1070 m), and Helipad 55 (1890 m, see Map 3).

SUMMARY OF RESULTS

Vegetation: Trees and Understory Plants

The RAP survey was the first to study the vegetation of this area of Irian Jaya, revealing a rich and unique flora. The vegetation of the Wapoga area appears to be fairly intact, with negligible anthropogenic disturbance outside the area logged around Siewa. Approximately 430 species of woody vascular plants were collected at three camps during the survey, Siewa Base Camp (80 m), Wapoga Alpha Camp (1070 m), and Helipad 55 (1890 m). Of 269 collections of palms and understory plants, 32 shrubs and herbs have been identified to species and 24 collections of palms have been identified. Most of the collected palms are new specimens for the Herbarium Bogoriense. One palm tree, *Licuala* sp., may be a new species. In addition, four tree collections probably represent undescribed taxa and others represent major range extensions or taxa previously known from only a few collections. Identification of many species was difficult due to the lack of fertile specimens. Therefore, further botanical work is required, preferably at a different time of year when the vegetation is flowering. Further study of the blackwater swamp forest near the Siewa Base Camp is also needed, as there is no information available regarding this vegetation type. The discovery of several new plant species indicates that this area urgently requires more intensive inventory efforts.

Aquatic insects

Eighteen sampling stations in the Wapoga River basin headwaters, ranging from sea level to 1050 meters elevation, were sampled for aquatic insects from 3 to 22 April 1998. Stations were located around four sites, Lower Wapoga River at the Wapoga Staging Area (10 m), Siewa Base Camp (80 m), Logari/Landing Site 21 (275 m), and Wapoga Alpha Camp (1070 m). Sampling concentrated on two major groups that had been employed in previous aquatic biodiversity surveys in New Guinea: Heteroptera (aquatic true bugs), and Zygoptera (damselflies), although other taxa were also collected on an opportunistic basis. At least 80 species in 34 genera of aquatic Heteroptera were collected, of which at least 36 species and two genera are new to science. Twenty-five species in twelve genera of Zygoptera were collected, of which at least two species appear to be new to science.

Aquatic insect diversity is very high throughout the region surveyed and appears to peak in the coastal plain to foothill transition zone near the Siewa base camp, at approximately 65 meters elevation. In addition, the survey area lies in a geological suture zone between the central and north coastal ranges, and contains a mixture of endemic elements from both mountain systems, further enhancing the richness of the biota. The collections obtained from this survey are highly significant, since they originate from an area never previously visited by scientific parties, and fill a major gap in our distributional and taxonomic knowledge of aquatic insects on New Guinea.

The current mineral exploration activities in the area, being restricted as they are to small and widely scattered exploration and drill sites, appear to have had little or no impact on the aquatic insect biodiversity of this area.

Ants

Two sites (lowland forest at Siewa Base Camp and montane forest at Wapoga Alpha Camp) were surveyed for ants over a two week period each. Traditional methods were employed in collecting samples of ants. In all, 223 individual samples were collected. Between the two sites, 196 species in 52 genera were collected (Siewa: 135 species, 47 genera; Wapoga: 96 species, 38 genera). Of the 196 species found, only 34 (17%) were common to the two sites; the majority of the shared species (20) are ants that inhabit the leaf litter. Sixteen species collected have not been previously recorded from Irian Jaya, but most are known from Papua New Guinea. Within those genera that have been studied in sufficient detail, a total of seventeen species belong to previously undescribed taxa. Descriptions of these taxa are now being prepared based on these collections. Once large and complex genera such as *Camponotus, Crematogaster,* and *Pheidole* are studied in greater detail, it is expected that additional undescribed species will be identified.

Fishes

The fishes of the Wapoga River System were surveyed at four sites (as described above for aquatic insects) between 3-

20 April 1998. Fishes were observed underwater with the use of a mask and snorkel and/or collected using rotenone and a seine-net at 18 sampling stations. Forty-six fish species belonging to 34 genera and 16 families were identified from the Wapoga River system. Three new species of fishes were collected during the survey, including two rainbowfishes (*Glossolepis leggetti* and *Melanotaenia rubripinnis*) and a goby (*Sicyopterus* sp.).

The fish fauna is typical of most freshwater localities in New Guinea, being dominated by relatively few families, particularly rainbowfishes, gobies, and gudgeons. The number of fish species diminishes upstream with increasing elevation and current velocity. A total of 39 fish species were recorded from lowland habitats versus only seven species for mountain streams. The majority of Wapoga fishes are geographically confined to northern New Guinea or range widely throughout the Indo-Australian or broader Indo-Pacific region. Fishes in the latter two categories generally possess marine larval stages and are found mainly in coastal streams. The presence of the three new species indicates the likelihood of a unique zoogeographic subprovince involving the Wapoga and other drainage systems of eastern Cenderawasih Bay. Particularly noteworthy is the presence of four species of rainbowfishes (Melanotaeniidae), the aquatic equivalent of the brightly colored bird-of-paradise family.

Exotic fish species were not found during the RAP survey in the Wapoga river. Fishes form an important part of the Wapoga River system biota and should form an integral part of any conservation programs that are implemented. The major potential threats to Wapoga aquatic systems are logging (habitat degradation) and transmigration (resultant introduced species).

Amphibians and Reptiles

A total of 47 frog and at least 25 reptile species were recorded during surveys at Siewa Base Camp, Wapoga Alpha Camp, and Helipad 55. The proportion of undescribed species, particularly among the frogs, was exceptionally high. At least 29 (>50%) of the frogs are undescribed, and several other species were collected for the first time since their discovery early this century. This RAP survey has increased the known frog fauna of Irian Jaya by nearly 30%. These findings highlight the inadequacy of fundamental knowledge of Irian Jaya's biodiversity. Additional biological surveys are urgently needed to determine which species are widespread, where endemics are found, and to document and prevent the spread of exotic species (e.g. *Bufo marinus*). Long term monitoring should be implemented for populations of several frog species that are ecologically and phylogenetically related to declining species in Australia to provide insight into causes and possible prevention of further declines.

Birds

Two hundred and thirteen (213) species of birds were identified during the RAP survey at four sites: Siewa Base Camp, Logari/Landing Site 21, Wapoga Alpha Camp, and Helipad 55. Birds were censused visually and aurally and a few mist nets were also set. The montane birds of Helipad 55 were largely typical of the Central Ranges of New Guinea. The lowland and hill forest birds of the other sites were essentially as would be expected in this part of the island. However, several very interesting records were made. Most notably, *Androphobus viridis* was observed at Helipad 55. This species is only known from a few locations, primarily in the Snow Mountains. One of the poorest-known birds of New Guinea, *Philemon brassi*, was fairly common at Wapoga Alpha and LS-21 Camps. This species was previously known only from a few locations in the Idenburg drainage and only a handful of specimens exist.

Mammals

Mammals were collected by live trapping and mist-netting bats. Since we were not able to hire local trackers and guides, it was not possible to survey marsupials. Eleven species of mammals, including seven species of bats, three rodents, and one marsupial, were encountered during the survey. Most of these mammal species are typical for the western end of the central ranges and have been previously recorded on the south side during Freeport's biodiversity surveys. It is recommended that additional mammal survey work be undertaken in the area and hopefully include hunting and a broader array of traps (e.g. harp traps for Microchiroptera).

OVERALL SUMMARY AND RECOMMENDATIONS

Biogeographic Divisions

The results from the RAP survey indicate that the Wapoga area likely straddles a boundary between two biogeographic subprovinces. Helipad 55 (1890 m) to the south is allied to the Snow Mountains whereas the four sites within the lower Wapoga area, Lower Wapoga River at the Wapoga Staging Area (10 m), Siewa Base Camp (80 m), Logari/Landing Site 21 (275 m), and Wapoga Alpha Camp (1070 m), are allied to the Van Rees Mountains, eastern Cenderawasih Bay and upper Rouffaer drainage (see Map 3). This latter area has endemic species that, when better known, could delineate a hitherto under-appreciated biogeographic subprovince. It will be important to gather more data and assess whether this area is sufficiently distinct to warrant modification of current protected area boundaries. At present, no protected

areas presently exist in this region of Irian Jaya. These findings highlight the urgent need for more biological surveys before the protected areas system in Irian Jaya can be refined or improved.

Impacts of Logging

Although the RAP survey was not designed to monitor environmental impacts of logging or geological exploration, it did provide opportunities to view impacts of these operations in the field. The impact of logging could not be fully assessed, but observations made during the RAP survey do indicate that more detailed study in the area could be rewarding. Logging impacts were clearly not uniformly detrimental across all taxa. Large, heavily hunted animals, such as goura pigeons and cassowaries were seen very close to the Siewa Base Camp in the logged forest, suggesting that these sensitive species can persist after logging if hunting is not too severe. We have no data on the logging operation, and it is possible that the concession was abandoned early. Floating timber downriver was apparently difficult due to the unpredictable and wide fluctuations in river level and flow velocity (P.T. Freeport staff, personal communications). If true, this would suggest inadequate planning occurred prior to initiating logging activities. With better advance planning, logging impacts could have be reduced by restricting logging to areas where river flow was adequate for extraction. Clearly a deciding factor in reducing the impact of logging was that settlers did not move into the area after the logging operation pulled out. Further investigation could help reveal which taxa are most sensitive to logging and possibly suggest ways to reduce logging impacts elsewhere in lowland Irian Jaya. In addition, it would be worthwhile to study regeneration in the logged forests around Siewa.

Impacts of Mining

The RAP team's use of geological exploration camps enabled firsthand observation of the impact of this activity. Overall, ecological impact of geological exploration appears to be minimal in this area. The use of helicopters rather than road building is probably the best way to minimize deleterious effects. The camps were small and sites abandoned less than six months before our visit were visibly recovering. Larger clearings for exploratory drilling will require longer to recover.

FURTHER CONSERVATION RECOMMENDATIONS

The high number of new species and species range extensions discovered during this short RAP survey to the Wapoga River Area of Irian Jaya highlight the need for more research on all taxonomic groups. Three unique features of this area make it especially desirable to undertake more biological surveys. 1) Few places anywhere are so biologically-rich yet so poorly-known by biologists. 2) Few places exhibit so little impact of human activity (outside of the logged Siewa area). 3) Few places that are so pristine and rich are still readily accessible to biologists due to the mining exploration logistical infrastructure.

Further surveys will add to our knowledge of the high diversity of the Wapoga River Area and will help to determine the types of conservation activities needed to preserve its unique biota. Meanwhile, efforts should be made to limit human impacts and prevent the introduction of exotic species into the area.

RINGKASAN EKSEKUTIF

PENDAHULUAN

Irian Jaya dengan luas 416.000 km^2 terletak di sebelah barat Pulau Papua, yang bertetangga dengan negara Papua New Guinea. Tingginya keanekaragaman hayati dan spesies endemik pada daerah dengan kepadatan penduduk yang rendah (2-6/ km^2), merupakan alasan utama bagi Conservation International untuk menggolongkan Irian Jaya sebagai satu-satunya "*Major Tropical Wilderness Area*" di Asia.

Besarnya keanekaragaman hayati yang ditemukan di pulau ini dimungkinkan oleh tingginya tingkat spesiasi akibat proses isolasi Irian sebagai sebuah pulau dan bentang alamnya yang tidak merata. Perjalanan melintasi Irian sedemikian sulitnya sehingga masyarakat asli dapat mengembangkan lebih dari 1000 jenis bahasa hanya dalam kurun waktu 50.000 tahun sejak pulau ini dihuni manusia.

Dibandingkan Papua New Guinea (PNG), yang menempati setengah pulau lainnya (475.369 km^2), keanekaragaman hayati Irian Jaya belum banyak diketahui. Misalnya, di PNG telah didokumentasikan sebanyak 510 spesies amfibi-reptil, sedangkan di Irian Jaya baru ditemukan 330 spesies. Tidak kurang dari 227 spesies mamalia telah tercatat di PNG, sedangkan di Irian baru tercatat 164 spesies.

Mengingat perkembangan yang ada saat ini, pembangunan di segala bidang merupakan kebutuhan yang tidak dapat ditunda lagi di Irian Jaya. Pemerintah bahkan mentargetkan tingkat pertumbuhan ekonomi hingga 10% per tahun yang akan berpengaruh pada tata guna lahan. Dengan demikian, inventarisasi keanekaragaman hayati Irian Jaya mutlak dilakukan pada saat ini, dengan mempertimbangkan prioritas wilayah sehingga rencana pembangunan tidak berbenturan dengan upaya-upaya konservasi.

Kawasan Wapoga di barat laut Irian Jaya dipilih sebagai lokasi survei RAP pertama di Irian Jaya karena data ekologi dan biogeografinya sangat tidak memadai dibandingkan daerah lain. Pemilihan lokasi tersebut sesuai dengan rekomendasi Lokakarya Penentuan Prioritas Konservasi Keanekaragaman Hayati Irian Jaya pada tahun 1997 di Biak, agar melakukan inventarisasi biologi di daerah yang minim informasi. Kondisi medan yang sulit ditembus telah berhasil menghambat pengrusakan lahan atau hutan berskala besar, namun di sisi lain hal tersebut juga menghalangi penelitian flora dan fauna di daerah ini. Saat ini pembangunan dalam bentuk transmigrasi, pembukaan hutan, pembuatan jalan, dan pertambangan berjalan sangat pesat di seluruh Irian Jaya dan tidak terkecuali Kawasan Wapoga. Survei biologi yang dikuti dengan kegiatan konservasi jelas sangat diperlukan.

Tujuan utama ekspedisi RAP adalah mensurvei suatu daerah yang belum pernah diteliti para ahli biologi dan menggunakan data yang dikumpulkan untuk memperkuat perencanaan konservasi di Irian Jaya. Kami percaya bahwa survei ini akan berfungsi sebagai model kerjasama dalam eksplorasi ilmiah antara berbagai peserta termasuk ahli konservasi, ilmuwan, industri swasta, dan organisasi pemerintah di masa yang akan datang.

Sebagian besar survei RAP dilakukan dalam kawasan drainase Sungai Wapoga, barat laut Irian Jaya (*lihat* Peta). Kawasan drainase Sungai Wapoga merupakan drainase terbesar kedua di utara Irian Jaya setelah Mamberamo. Bagian ujung Sungai Wapoga menyatu dengan Sungai Derewo. Karena sebagian Derewo mengalir pada muara tersendiri, kedua sistem tersebut umumnya dianggap sebagai dua perairan yang terpisah. Dengan demikian, dalam laporan ini disajikan data penelitian dari dua daerah drainase, yang terdiri dari empat lokasi sampling di delta Sungai Wapoga, dan satu lokasi (Helipad 55) di delta Sungai Derewo. Meskipun beberapa kegiatan pembalakan pernah terjadi sebelumnya, sebagian besar daerah penelitian masih berada dalam kondisi murni dan utuh.

Ekspedisi RAP ini dilakukan oleh Conservation International bekerjasama dengan Lembaga Ilmu Pengetahuan

Indonesia (LIPI) pada tanggal 31 Maret sampai 2 Mei 1998. Tim RAP terdiri dari 13 ilmuwan, yang berasal dari Indonesia (6), Amerika Serikat (4), Australia (2) dan Inggris (1). Selama ekspedisi RAP, tim ini melakukan survei vegetasi (pohon dan vegetasi lantai hutan), serangga air, semut, ikan, amfibia dan reptil, burung, serta mamalia. Setiap takson disurvei menggunakan metodologi pengambilan sampel yang akan menghasilkan informasi sebanyak-banyaknya dalam waktu sesingkat mungkin mengingat peninjauan ke lokasi terkadang hanya berlangsung beberapa hari saja (*lihat* Lampiran 1 untuk waktu pengambilan sampel).

Sebanyak 28 survei RAP yang meliputi habitat daratan, perairan tawar, dan laut telah dilakukan di 14 negara, termasuk Filipina, Papua New Guinea, dan Kepulauan Solomon. Survei RAP dirancang untuk mengumpulkan data biologi dengan cepat yang dapat digunakan dalam perencanaan konservasi. Kegiatan ini merupakan survei RAP yang pertama di Indonesia.

RINGKASAN HASIL

Vegetasi: Pohon dan Tumbuhan lantai hutan

Survei RAP ini merupakan studi vegetasi pertama yang dilakukan di lokasi tersebut, yang memperlihatkan kekayaan dan keunikan floranya. Vegetasi Kawasan Wapoga tampak relatif utuh, dengan tingkat gangguan antropogenik yang masih rendah di luar daerah pembalakan hutan sekitar Siewa. Kira-kira 430 spesies tumbuhan berpembuluh kayu telah dikoleksi di tiga stasiun selama survei; Siewa (80 m /dpl.), Wapoga Alpha (1070 m dpl.), dan Helipad 55 (1890 m dpl.). Tim RAP berhasil mengumpulkan 269 koleksi palem dan tumbuhan lantai hutan, serta 32 koleksi semak dan herba. Dari koleksi palem, telah berhasil diidentifikasi sebanyak 24 koleksi palem sampai tingkat spesies. Sebagian besar palem yang dikoleksi merupakan spesimen baru bagi Herbarium Bogoriense. Palem raksasa, *Licuala* sp., diduga sebagai spesies yang baru ditemukan. Sebagai tambahan, empat koleksi pohon diperkirakan mewakili taksa yang belum dideskripsikan, sementara koleksi-koleksi lain menunjukkan perluasan daerah sebaran atau mewakili taksa yang sebelumnya hanya diketahui dari beberapa koleksi. Banyak pula spesies yang sulit diidentifikasi karena tidak adanya spesimen fertil (tidak memiliki bunga). Oleh karena itu, diperlukan penelitian botani lebih lanjut, terutama pada musim-musim berbunga. Penelitian lebih lanjut pada hutan rawa dekat stasiun Siewa juga perlu dilakukan, mengingat tidak adanya informasi yang tersedia tentang tipe vegetasi daerah itu. Penemuan beberapa spesies tumbuhan baru menunjukkan bahwa upaya inventarisasi yang lebih intensif sangat diperlukan bagi kawasan ini.

Serangga Air

Pengambilan sampel serangga air dilakukan pada 18 stasiun di sepanjang delta Sungai Wapoga, dengan ketinggian yang berkisar antara 0 - 1050 m di atas permukaan laut dan dilangsungkan dari 3 - 22 April 1998. Stasiun berada di sekitar empat lokasi, Sungai Wapoga Bawah yang berada pada area pendaratan Wapoga (10 m dpl.), Siewa (80 m dpl), Logasari/ Landasan 21 (275 m dpl), dan Wapoga Alpha (1070 m dpl). Pengambilan sampel dikonsentrasikan pada dua kelompok utama yang sebelumnya telah digunakan dalam survei keragaman biota perairan di Papua New Guinea: Heteroptera (kepik air sejati) dan Zygoptera (lalat sehari). Namun demikian, taksa lain juga dikoleksi jika memungkinkan. Paling sedikit 80 spesies dari 34 genera Heteroptera akuatik telah dikoleksi, 36 spesies dan 2 genera di antaranya merupakan jenis-jenis baru. Sementara itu, 25 spesies dari 12 genera Zygoptera juga dikoleksi, 2 spesies di antaranya adalah jenis baru.

Di seluruh daerah yang disurvei keanekaragaman serangga air yang ditemukan sangat tinggi, dan paling tinggi terdapat di daerah pesisir sampai zona transisi kaki bukit, di dekat Siewa pada ketinggian sekitar 65 m d.p.l.. Selain itu, daerah survei terletak di dalam zona patahan geologis antara garis pantai tengah dan utara, dan mengandung campuran elemen endemik dari kedua sistem pegunungan, sehingga semakin memperkaya biota daerah itu. Koleksi yang diperoleh dari survei ini mempunyai arti yag sangat penting, karena spesimen-spesimen tersebut berasal dari daerah yang sebelumnya tidak pernah dikunjungi ilmuwan, sehingga dapat mengisi kesenjangan dalam pengetahuan kita tentang sebaran dan taksonomi serangga air di Irian.

Semut

Survei dilangsungkan di dua lokasi (hutan dataran rendah di Siewa dan hutan pegunungan di Wapoga Alpha), masing-masing selama 2 minggu. Sampel semut dikoleksi menggunakan metode tradisional dan berhasil mengumpulkan 223 individu. Antara kedua lokasi sejumlah 196 spesies dari 52 genera telah dikoleksi (Siewa: 135 spesies, 47 genera; Wapoga: 96 spesies, 38 genera). Dari 196 spesies yang ditemukan, hanya 34 (17%) yang merupakan spesies umum pada kedua lokasi; sebagian besar (20) adalah jenis-jenis yang hidup pada serasah. Enam belas spesies yang dikoleksi belum pernah dilaporkan sebelumnya ada di Irian Jaya, tetapi sebagian besar telah diketahui dari Papua New Guinea. Dari genera yang telah dipelajari secara rinci diketahui bahwa 17 spesies di antaranya termasuk ke dalam taksa yang belum pernah dideskripsikan. Deskripsi taksa tersebut berdasarkan koleksi ini sekarang sedang dipersiapkan. Bila genera besar

dan kompleks seperti *Camponotus*, *Crematogaster*, dan *Pheidole* telah dipelajari dengan rinci, diharapkan jumlah spesies yang akan teridentifikasi menjadi bertambah.

Ikan

Survei ikan-ikan yang hidup dalam sistem Sungai Wapoga dilakukan pada empat lokasi yang sama dengan lokasi sampling serangga air, antara tanggal 3-20 April 1998. Ikan diamati di bawah permukaan air dengan masker dan snorkel, serta dikoleksi menggunakan *rotenone* dan *seine-net* pada 18 stasiun pengambilan sampel. Sebanyak 46 spesies ikan yang tergolong ke dalam 34 genera dan 16 famili telah diidentifikasi. Tiga spesies baru ditemukan selama survei, termasuk 2 ikan pelangi (*Glossolepis* sp. dan *Melanotaenia* sp.) dan 1 ikan gobi (*Sicyopterus* sp.).

Fauna ikan yang ditemukan pada kebanyakan perairan tawar Irian terdiri dari spesies-spesies yang hampir sejenis, biasanya hanya didominasi beberapa famili saja, terutama ikan pelangi, gobi, dan gudgeons. Jumlah spesies berkurang ke arah hulu dengan semakin meningkatnya ketinggian dan kecepatan arus. Total spesies ikan yang dikoleksi dari habitat dataran rendah berjumlah 39 jenis sedangkan dari daerah hilir di pegunungan hanya ditemukan 7 spesies. Sebagian besar ikan yang hidup di Wapoga mempunyai sebaran geografis terbatas di Irian bagian utara. Namun, ada juga jenis-jenis dengan kisaran geografis yang meliputi kawasan Indo-Australia atau lebih luas lagi sampai Indo-Pasifik. Ikan dengan sebaran geografis luas umumnya mempunyai fase larva yang hidup di laut dan terutama ditemukan di perairan dekat pesisir. Ditemukannya tiga spesies baru mengindikasikan bahwa kemungkinan Kawasan Wapoga dan sistem drainase Teluk Cendrawasih bagian timur lainnya membentuk sub propinsi zoogeografis tersendiri. Temuan lain yang penting adalah keberadaan empat spesies ikan pelangi (Melanotaeniidae) yang mempunyai warna-warna cemerlang sehingga dapat disetarakan sebagai bentuk akuatik famili burung cendrawasih.

Spesies-spesies eksotik/introduksi tidak tampak dijumpai selama survei di Sungai Wapoga. Fauna ikan merupakan bagian penting dari biota Sungai Wapoga dan selayaknya menjadi bagian integral dalam program konservasi yang akan diimplementasikan. Ancaman terbesar bagi biota akuatik Sungai Wapoga adalah pembalakan hutan (degradasi habitat) dan para transmigran yang seringkali membawa spesies introduksi.

Amfibia dan Reptil

Total 47 spesies katak dan sedikitnya 25 spesies reptil berhasil dicatat selama survei di Siewa, Wapoga Alpha, dan Helipad 55. Proporsi spesies yang belum dideskripsikan, terutama di antara jenis-jenis katak, sangat tinggi. Sedikitnya 29 jenis (> 50%) katak yang ditemukan belum pernah dideskripsi, dan beberapa spesies lain dikoleksi untuk pertama kalinya sejak ditemukan awal abad ini. Survei RAP ini meningkatkan jumlah fauna katak Irian Jaya yang telah diketahui sebesar hampir 30%. Penemuan ini menunjukkan tidak memadainya pengetahuan dasar tentang keanekaragaman hayati Irian Jaya. Tambahan survei biologi perlu segera dilakukan untuk menentukan spesies-spesies yang mempunyai sebaran luas, daerah endemik, dan untuk mendokumentasikan serta mencegah penyebaran spesies eksotik (misalnya *Bufo marinus*). Monitoring jangka panjang perlu diimplementasikan bagi beberapa populasi katak yang mempunyai keterkaitan ekologi dan filogenetik dengan spesies di Australia yang mengalami penyusutan. Kegiatan tersebut untuk mengidentifikasi faktor-faktor penyebab penyusutan sehingga penurunan populasi lebih lanjut dapat dicegah.

Burung

Selama survei RAP telah berhasil diidentifikasi sebanyak 213 spesies burung di 4 lokasi (Siewa, Logari/Landasan 21, Wapoga Alpha, dan Helipad 55). Sensus dilakukan secara visual dan berdasarkan pendengaran. Selain itu, jaring kabut (*mistnet*) juga digunakan di dalam sensus. Kebanyakan burung pegunungan yang ditemukan di Helipad 55 adalah jenis-jenis yang umum untuk bagian tengah Irian. Sementara itu, burung-burung yang ditemukan pada hutan dataran rendah dan perbukitan adalah jenis yang memang hidup di bagian pulau ini. Namun, beberapa temuan menarik yang menonjol adalah *Andropholus viridis* yang ditemukan pada Helipad 55. Spesies ini sebelumnya hanya diketahui dari beberapa lokasi, terutama pada Pegunungan Sudirman (Snow Mountains). Salah satu jenis burung Irian Jaya yang paling sedikit diketahui, *Philemon brassi*, juga cukup umum ditemukan pada Wapoga Alpha dan LS 21. Sebelumnya jenis ini hanya diketahui dari beberapa lokasi di drainase Idenburg, dan spesimen koleksi yang ada juga sangat sedikit.

Mamalia

Spesimen mamalia dikoleksi menggunakan perangkap hidup dan jaring kabut untuk kelelawar. Karena kami tidak dapat mempekerjakan penunjuk jalan dan pemandu lokal, survei marsupilia tidak mungkin dilakukan. Sebelas spesies mamalia yang terdiri dari 7 spesies kelelawar, 3 spesies rodensia, dan 1 spesies marsupialia ditemukan selama survei. Sebagian besar mamalia yang ditemukan merupakan jenis-jenis umum untuk ujung barat bagian tengah Irian dan sebelumnya telah didokumentasikan dari sisi selatan oleh tim survei keanekaragaman hayati yang dilakukan oleh tim peneliti lain.

Survei RAP kali ini merekomendasikan perlunya penelitian lebih lanjut tentang fauna mamalia daerah ini. Diharapkan survei yang akan datang menerapkan metode perburuan dan penggunaan tipe perangkap yang lebih beragam (misalnya perangkap model harpa untuk Microchiroptera).

RINGKASAN KESELURUHAN DAN REKOMENDASI

Pembagian Biogeografi

Hasil-hasil survei RAP mengindikasikan bahwa daerah Wapoga mungkin membentang antara dua sub propinsi biogeografi. Helipad 55 (1890 m dpl.) di sebelah selatan berhubungan dengan Pegunungan Salju , sedangkan ke empat lokasi lainnya masuk ke dalam daerah Wapoga bawah. Sungai Wapoga Bawah yang meliputi daerah pendaratan Wapoga, Siewa, Logari/Landasan 21, dan Wapoga Alpha berkaitan dengan Pegunungan Van Rees, bagian timur Teluk Cendrawasih, dan drainase Rouffaer atas (*lihat* Peta). Daerah terakhir ini mengandung spesies endemik, yang bila sudah diketahui lebih baik, dapat menentukan batas sub propinsi biogeografi yang selama ini kurang mendapat perhatian. Adalah penting untuk mengumpulkan lebih banyak data dan memperkirakan apakah daerah ini cukup berbeda untuk menentukan perlu tidaknya memodifikasi batas-batas kawasan lindung yang ada sekarang. Saat ini, di dalam bagian Irian Jaya tersebut tidak ada kawasan lindung. Penemuan ini memperlihatkan pentingnya survei biologi lebih lanjut sebelum sistem kawasan lindung di Irian Jaya direvisi atau diperbaiki.

Dampak Pembalakan

Meskipun survei RAP tidak dirancang untuk memantau dampak pembalakan dan eksplorasi geologi terhadap lingkungan, kegiatan ini tetap memberikan kesempatan untuk memperkirakan dampak dari kegiatan-kegiatan tersebut. Dampak pembalakan tidak dapat diperkirakan dengan rinci, namun pengamatan yang dibuat selama survei menunjukkan bahwa penelitian lebih lanjut bisa sangat bermanfaat. Dampak merugikan dari kegiatan pembalakan jelas tidak merata untuk semua taksa. Satwa berukuran besar dan berat, seperti burung dara mahkota dan kasuari, terlihat sangat dekat di sekitar Siewa, dalam hutan yang dibuka. Hal itu menunjukkan bahwa spesies-spesies sensitif dapat bertahan setelah pembalakan jika tekanan perburuan tidak terlalu berat. Kami tidak mempunyai data tentang operasi pembalakan, dan mungkin daerah konsesi ditinggalkan lebih awal.

Pengaliran balok-balok kayu ke arah hilir sungai oleh para pembalak hutan tampaknya sulit dilakukan karena fluktuasi permukaan air dan arus sungai yang sangat besar dan tidak dapat ditebak (Staf PT. Freeport, *pers.com*. *penuturan pribadi*). Jika benar, hal ini menunjukkan kurangnya perencanaan sebelum kegiatan pembalakan dimulai. Dengan perencanaan yang lebih baik, dampak dapat dikurangi dengan membatasi daerah pembalakan hutan pada tempat-tempat yang arus sungainya cukup untuk pengambilan kayu. Jelasnya, faktor penentu dalam mengurangi dampak adalah bahwa penduduk tidak berpindah ke daerah yang telah dibuka setelah operasi pembalakan hutan dihentikan. Penelitian lebih lanjut dapat membantu menentukan taksa mana yang paling sensitif terhadap kegiatan pembalakan dan mungkin dapat meberikan saran tentang cara-cara mengurangi dampak di tempat-tempat lain pada dataran rendah Irian Jaya. Selain itu, studi mengenai proses regenerasi di daerah pembukaan hutan di sekitar Siewa juga sangat menarik dan penting.

Dampak Penambangan

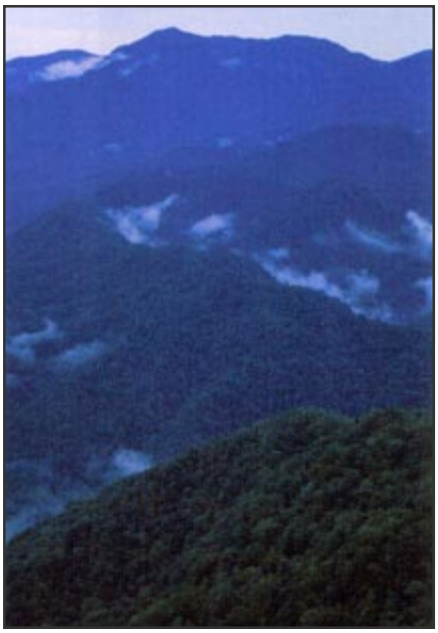
Penggunaan pangkalan eksplorasi oleh tim RAP memungkinkan pengamatan langsung dampak kegiatan tersebut. Secara keseluruhan, dampak ekologis eksplorasi di daerah ini tampak minimal. Penggunaan helikopter dibandingkan jalan raya mungkin merupakan cara terbaik untuk mengurangi dampak yang merugikan. Pangkalan-pangkalan yang dibangun berukuran kecil dan kondisi alam di sekitar stasiun yang ditinggalkan kurang dari 6 bulan sebelum kunjungan kami tampak mulai pulih. Daerah bukaan yang lebih besar untuk tempat pengeboran memerlukan waktu pemulihan lebih lama. Namun, tempat-tempat tersebut tidak banyak dan pengaruhnya tidak lebih besar dibandingkan longsor alamiah yang sering terjadi di seluruh pegunungan Irian. Jika tidak ada spesies eksotik yang diintroduksi, perburuan dilarang, dan bahan kimia beracun tidak dikeluarkan, kegiatan eksplorasi seperti ini mungkin mempunyai dampak jangka panjang yang sangat kecil di Irian Jaya.

REKOMENDASI KONSERVASI LEBIH LANJUT

Tingginya jumlah spesies baru dan perluasan daerah sebaran spesies yang ditemukan selama survei RAP di Kawasan Sungai Wapoga, Irian Jaya, memperlihatkan perlu dilakukan lebih banyak penelitian pada semua kelompok taksa. Tiga karakteristik unik daerah ini yang meyebabkan perlu dilakukan lebih banyak survei biologi, 1) Hanya beberapa tempat di dunia yang memiliki keanekaragaman biologi sangat tinggi, tetapi juga belum banyak diketahui para ahli. 2) Sedikit sekali tempat yang memperlihatkan dampak kegiatan manusia yang sangat kecil (di luar daerah pembalakan Siewa). 3) Hanya sedikit tempat di dunia yang sedemikian murni dan kaya namun mudah dijangkau berkat infrastruktur logistik

kegiatan eksplorasi.

Survei-survei lebih lanjut akan menambah pengetahuan kita tentang keragaman yang tinggi pada Kawasan Sungai Wapoga dan akan membantu menentukan jenis kegiatan konservasi yang diperlukan untuk melestarikan keunikan biotanya. Sementara itu, perlu dilakukan upaya-upaya untuk membatasi dampak manusia dan mencegah introduksi spesies eksotik ke dalam daerah tersebut.



Michael P. Moore

The Wapoga River Area, northwestern Irian Jaya, Indonesia.

Michael P. Moore

Stream and lowland forest vegetation near Logari Landing Site 21 (275 m).

Michael P. Moore

RAP Team Leader, Dr. Andy Mack, in montane forest at Helipad 55 (1890 m).

Michael P. Moore

Aerial view of Siewa Base Camp area, along the Tirawiwa River (80 m).

Michael P. Moore

Hill forest at Wapoga Alpha Camp (1070 m).

Michael P. Moore

Emergent *Agathis* sp. (Araucariaceae) at Wapoga Alpha Camp.

Michael P. Moore

Ants (*Leptomyrmex flavitarsis*) carrying a beetle carcass at Wapoga Alpha Camp.

Gerald Allen

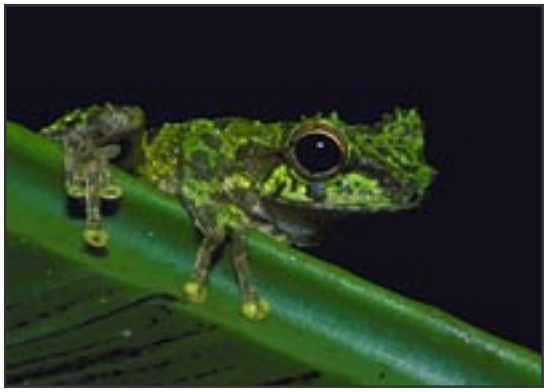
Chilatherina alleni from the waters near Siewa Base Camp.

Michael P. Moore

Tropidonophis multiscutellatus collected at Wapoga Alpha Camp.

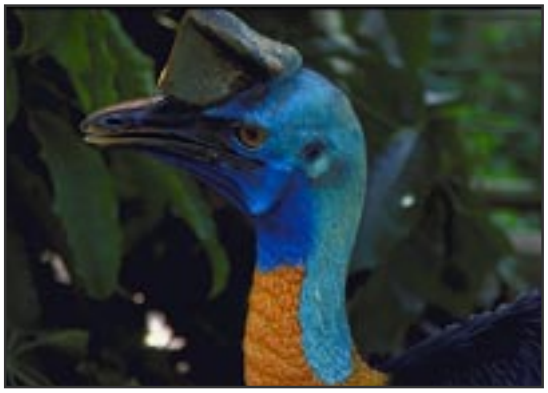
Michael P. Moore

Neurothemis sp. (Libellulidae) from Siewa Base Camp.



Michael P. Moore

Litoria sp. – one of 29 new frog species from the Wapoga River Area (Wapoga Alpha Camp).



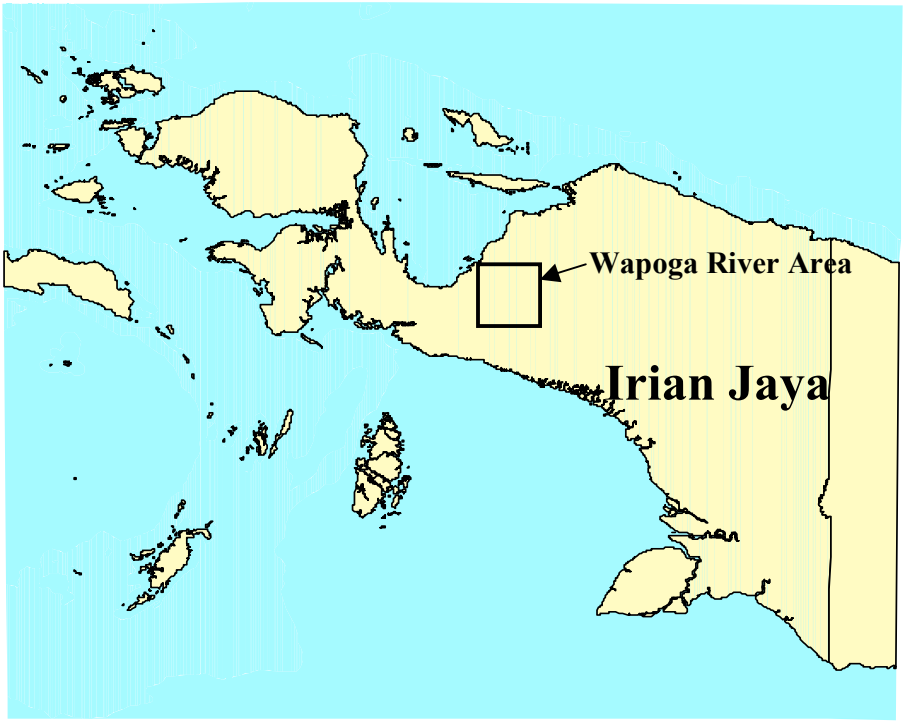
Michael P. Moore

The Northern Cassowary, *Casuarius unappendiculatus*, was found in good populations at Siewa Base Camp, indicating that hunting was not prevalent.

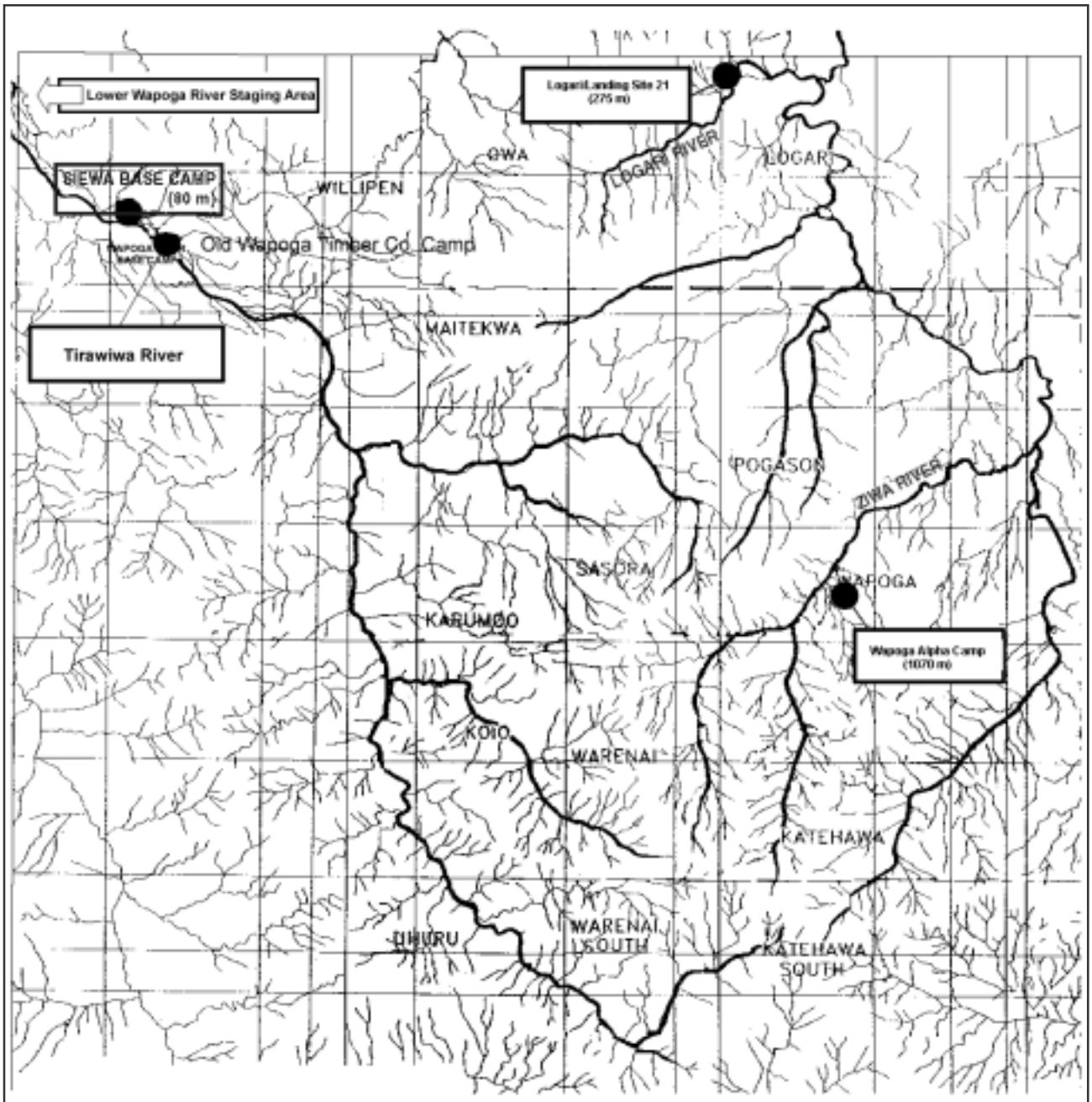
Michael P. Moore

The New Guinea Horseshoe Bat, *Rhinolophus euryotis*, from Wapoga Alpha Camp.

Map 1. Location of Irian Jaya, Indonesia on the western portion of the island of New Guinea in the Asia Pacific region.



Map 2. Location of theWapoga River Area in northwestern Irian Jaya, Indonesia.



Map 3. RAP survey Sites in the Wapoga River Area, Northwestern Irian Jaya. March 31 - May 2, 1998. Helipad 55 is located south of this map.
The Wapoga River lies to the north of this map; the Lower Wapoga River Staging Area to the northwest. Basemap courtesy of P.T. Freeport.

CHAPTER 1

INTRODUCTION TO IRIAN JAYA, INDONESIA AND THE WAPOGA RIVER AREA

Irian Jaya

(Information from the Irian Jaya Biodiversity Conservation Priority-Setting Workshop, 7-11 January 1997; Supriatna et al. *in press*)

Biodiversity

Irian Jaya, located on the western half of the island of New Guinea in the Indonesian archipelago, is perhaps the biologically richest and most diverse assemblage of ecosystems in the tropical Pacific. With an area of over 416,000 km^2, it contains a significant portion of the planet's remaining tropical forests, as well as some of the most pristine coral reefs on Earth. Irian Jaya is home to a unique array of plant and animal species, including birds of paradise, birdwing butterflies, tree kangaroos, cuscus, bandicoots, orchids, *Araucaria* trees, and rhododendrons. In addition, over 250 different ethnic groups live in Irian Jaya, each with rich cultural traditions, languages, and sets of inter-relationships with their environment.

In January 1997, the biodiversity of Irian Jaya was reviewed and evaluated at the Irian Jaya Biodiversity Conservation Priority-Setting Workshop. This workshop, held in Biak, Irian Jaya, resulted in some remarkable findings. Scientists at the workshop confirmed that Irian Jaya contains very high levels of biodiversity, species endemism, and unique natural features that are of global importance. A new calculation indicates that Irian Jaya may have at least 20-25,000 species of vascular plants. This number is significantly higher than previously estimated. Furthermore, with at least 164 species of mammals, 329 reptiles and amphibians, some 650 birds, about 250 freshwater and 1200 marine fishes, an estimated 150,000 insects, and many hundreds of other freshwater and marine invertebrates, Irian Jaya contains nearly one half of Indonesia's total biodiversity. As a result, Indonesia now appears to be the "# 1" biodiversity country in the world, surpassing Brazil and Colombia, which until now were thought to top the list. Irian Jaya is clearly among the most biologically important parts of the planet.

The 1993 Biodiversity Action Plan for Indonesia gave Irian Jaya the highest biodiversity rankings for species richness and endemism for birds and plants in Indonesia, plus very high rankings for mammals and reptiles. New Guinea's flora combines elements of two major bio-regions, southeast Asia and Australia. Indonesia is the only nation in the world that straddles two major bio-regions, giving Indonesia one of the most diverse biotas of any nation. There are very few vegetation studies from anywhere in New Guinea and none published for Irian Jaya. Based on vegetation studies conducted in neighboring Papua New Guinea (PNG), undisturbed humid forests in Irian Jaya are more diverse than many of the tropical forests studied in South America, Africa or Southeast Asia.

Biogeography

Irian Jaya's enormous altitudinal range (from sea level to the highest mountains in the Asia-Pacific region), helps give rise to an extraordinary array of terrestrial ecosystems. These include the equatorial glaciers and surrounding alpine valleys, a variety of montane forests in the many rugged ranges throughout the province, a diverse mix of lowland rainforest types, swamps, savanna forests, and mangroves. The natural landscape, ecological processes (e.g., water and air purification), and inhabitants (plants, animals, and microorganisms) of Irian Jaya are still primarily intact, making it one of the largest remaining tropical wilderness areas in the world. According to the 1993 Biodiversity Action Plan for Indonesia, over 90% forest cover still remains.

The island of New Guinea is divided between the countries of Indonesia and PNG; plant and animal distributions, however, are independent of the political boundaries. It is the world's second largest island, surpassed only by Greenland in size. The island of New Guinea is bisected lengthwise east to west by a massive complex of mountains, the largest and highest mountain chain in the Asia-Pacific region. Furthermore, there are a number of isolated ranges throughout the island; many with their own distinctive biota. Deep valleys and rivers further dissect the island. The mountains, rivers and valleys all act as biological barriers to the movement or migration of plants and animals around the island. Indeed, geologically, the island is extremely complex, comprised of many terrains that have accreted. The biogeography of the island often reflects the independent evolutionary history of these different terrains. New Guinea is thus a complicated biogeographic mosaic, split into roughly four areas: northern, southern, Vogelkop (or Bird's Head), and highland biota. The complexity of the province's biogeography contributes to its rich biodiversity.

Most plant and animal species in Irian Jaya have restricted ranges as a consequence of the complex geologic history of the island and its numerous barriers to dispersal. Structurally similar forests separated by relatively small barriers, or even adjacent but having different geological origins, may contain quite different combinations of plant and animal species.

Underlying variations in abiotic environmental factors (such as soil type, moisture and humidity levels) often lead to patchy distribution patterns for plants and animals, with individuals or groups spatially separated from one another. Fragmentation of the landscape through logging or agricultural settlements can easily cut populations off from each other, creating what are in effect biological "islands." This situation can greatly increase a species' vulnerability to extinction. Inability to disperse or migrate can lead to inbreeding depression (reduction in rate of reproduction or offspring survival due to an accumulation of lethal genes in the population through inbreeding), as well as the loss of the ability to recolonize following local extinctions.

The island's rich diversity and unique life forms are due in part to its position at the crossroads of the Asian and Australasian biogeographic regions. Irian Jaya contains predominantly Australasian species, but shares some Asian plant and animal species with western Indonesia. The combination of geographical isolation and environmental variation have fostered the high levels of speciation and endemism found in Irian Jaya.

Threats and Information Needs

Until recently, Irian Jaya was one of the most remote and obscure areas of the world. Its isolation helped to conserve its biodiversity. Modern technology, however, has changed all this and has made the island more accessible. The abundance of wealth contained in Irian Jaya's natural resources has now captured the attention of the world's top scientists, businessmen, and politicians. The major threats to Irian Jaya's ecosystems come from major infrastructure projects such as dams and roads, large- and small-scale mining, and oil and gas development. Forest conversion for transmigration and plantations, agriculture, logging, and the introduction of exotic species, also present serious threats. Marine ecosystems in the region are primarily endangered from dynamite and cyanide fishing, siltation effects resulting from deforestation, and overexploitation of fish resources.

Most of these activities will permanently alter the landscape of Irian Jaya. Clearly, development planning in Irian Jaya is most successful when there is sufficient understanding of the long-term ecological and social costs of these activities. While some forms of economic progress are necessary and desirable, development projects must take great care to minimize damage to Irian Jaya's unique natural and cultural heritage. Integrating conservation considerations into development planning can help Irian Jaya conserve its resources while promoting effective and sustainable economic development.

Despite Irian Jaya's importance to global biodiversity, there has been little research conducted in the province. Few data are available on the area's ecology, biological interactions, or ecosystem processes. Socio-economic research in Irian Jaya has also been very limited. Far more scientific research has been carried out in western Indonesia and neighboring Papua New Guinea. The existing biological and anthropological data are insufficient to aid in making informed policy decisions about specific development or conservation plans.

The Wapoga River Area of Northwestern Irian Jaya, Indonesia

The Wapoga River drainage is the second largest drainage in northern Irian Jaya (after the Mamberamo), occupying a southeast to northwest oriented catchment approximately 130 km in length (see Map 3). The river drains the western end of the north coastal Van Rees Mountains at the point where they join the northern face of the Irian Jaya central ranges. The river's main headwater tributary, the Ziwa, originates at elevations near 3000 m in the ophiolite and metamorphic belts of the central ranges, then flows northward in a rocky, steeply descending bed for approximately 40 km before joining with the Owa, which heads toward the western tip of the Van Rees Mountains, to form the main stem of the Wapoga. Below this confluence, the river's bed profile becomes more gradual, and it turns northwest, entering a broad, swampy plain lying inland of the coast.

As with many rivers in this section of Irian Jaya, the Wapoga has an inland zone of alluvial deposition at the point where it leaves the mountains and enters the lowlands, occupying a braided channel for 10 to 15 km beyond the mountain front. Beyond this, the river meanders for approximately 80 km across the coastal lowlands, receiving numerous inflow tributaries. The character of these tributaries is affected by the regions from which they originate; those entering from the north begin in the coastal swamps and have black waters, while those entering from the south originate on the northern face of the central ranges, and are pale and silty. Approximately 5 km before reaching the sea the river cuts through an elevated limestone ridge, then continues to its terminus at the southeastern end of Cenderawasih Bay. The river mouth opens directly into the bay, with no extensive delta or mangrove estuary.

The terminal reaches of the Wapoga River are commingled with those of the Derewo River, a drainage that occupies an elongate basin approximately 200 km long that cuts eastward along strike into the Irian Jaya central highlands. Although longer than the Wapoga, the Derewo River drains a smaller area due to the confined nature of its catchment. Technically, the two rivers might be considered part of the same drainage system, since a portion of the Derewo outflow joins the Wapoga in the swampy area upstream of the coastal limestone ridge. However, because a portion of the Derewo also flows to an independent terminus, the systems are generally considered as separate entities, as is the case in this report.

RAP Survey Sites in the Wapoga River Area, Irian Jaya, Indonesia

The following five principal sites, all located within the Kabupaten Paniai region of Irian Jaya, were surveyed during the RAP expedition to the Wapoga River Area. Field work was undertaken from five camps, all of which were former or active camps of P.T. Freeport Exploration. Not all RAP scientists visited all sites, and not all taxonomic groups were surveyed at each site. See Appendix 1 for a sampling timeline for each RAP scientist and taxonomic group.

Lower Wapoga River at the Wapoga Staging Area.
2° 43.40' S, 136° 26.00' E. Elevation: 10 m a.s.l.
Fishes and aquatic insects were sampled at this site.
No terrestrial work was undertaken here.

The terminal reach of the Wapoga River follows a sinuate course across plains of Quaternary alluvium before cutting through a low ridge of Pliocene limestone just upstream of its mouth. The river channel is deep and bordered by steep, muddy banks, with occasional higher bluffs where it passes through the limestone ridge, and has a meander factor of about 2:1, based on speed versus time calculations during boat traverses compared to GPS straight line distance measurements. Tributaries emerging from the alluvial plains bordering the river are deep and slow, with beds of fine silt and sand. By contrast, the tributary streams draining the limestone ridge are clear and spring fed, with gravel beds. Surveys on the lower Wapoga were made in the vicinity of the PTFI Wapoga Staging Area, which is situated at the upstream end of the limestone exposure. Aquatic samples were taken from the main river itself, and from a variety of tributaries draining both alluvial and limestone catchments.

Siewa Base Camp.
3° 02.202' S, 136° 22.515'E. Elevation: 80 m a.s.l.
All taxonomic groups were sampled at this site.

Siewa is the base camp for Freeport's geological investigations of their Exploration Block II. The name of the river near the Siewa Base Camp is a matter of uncertainty; the most common orthography, adopted herein, was "Tirawiwa", but the variations "Tiawiwa" and "Tiabiwa" were also employed by the local Irianese. The Tirawiwa is a large, powerful river occupying an elongate catchment running northwestward out of the Eocene ophiolite belt in the central ranges, and crossing a narrow band of Tertiary volcanic formations in the mountain foothills. As with the main stem of the Wapoga River, the Tirawiwa has an extensive zone of alluvial deposition at the point where it exits the mountains, forming essentially an inland delta. The river in this area splits into numerous braided and interconnected channels, separated by forested islands of alluvium. Although the main river is swift and silty, many of the side channels contain clear, gently flowing water, and are buffered by networks of cobble bars from the effects of the numerous spates that characterize this section of the river. The bed materials of this middle section of the Tirawiwa consist of a geologically diverse array of water rounded cobbles, composed of ophiolite materials (basalt, gabbro, diabase, and serpentine) intermixed with Tertiary volcanics and associated sediments similar to those seen along the Logari River.

The Siewa Base Camp is just downstream of the river's exit point from the mountains at 65 m elevation. Surveys in this area were made along the main river and associated overflow channels, and along small tributary creeks descending from the outermost spurs of the mountain foothills. Aquatic collections were also made on the alluvial outwash plains bordering the river channel, which contained numerous standing pools in the lowland rain forest. Other aquatic collections were drawn from the borrow pits created during the construction of the Siewa airstrip and antecedent Wapoga Timber Company logging roads.

The area was selectively logged in previous years, with operations having ceased in October 1997. The forest was laced with abandoned logging roads and skidder tracks. The primary logging roads were flanked by heavy disturbance that was cloaked with *Ipomea* vine. Away from the main tracks the forest was moderately disturbed, with the canopy broken due to the timber removed. Birds were surveyed along these logging roads, particularly those to the east of the Base Camp that entered the logged forest. The area was lowland, alluvial rainforest and still showed indications of high diversity; if not additionally disturbed this forest could possibly recover from the logging. Just a few kilometers east from the Base Camp the foothills were clearly visible. Judging from aerial flyovers in the area, these hills appear not to have been logged and probably exhibit greater diversity of primary species than currently found in the logged alluvial forest. The region has apparently never been densely populated by Irianese people.

Logari/ Landing Site 21 (LS-21).
3° 00.348' S, 136° 33.412' E. Elevation: 275 m a.s.l.
Birds, fishes and aquatic insects were sampled at this site.

This site was an active exploration camp of P.T. Freeport. The Logari River occupies a compact tributary catchment to the Ziwa River, lying north of the first range of mountain foothills at elevations between 300 and 500 m. The river has a relatively high gradient bed profile, draining an area of low, steep ridges formed from Tertiary volcanics and associated sedimentary formations, some of the latter hydrothermally altered. The bed materials thus consist of a mixture of rounded sedimentary cobbles and more irregular igneous and metamorphic fragments, the most notable of these being a dense, dark hornfels. Aquatic surveys were made along the main river and several tributaries in the vicinity of PTFI Landing Site 21, and along two major tributaries lying upstream of this site. These latter two streams correspond to LO-19-4 and LO-47 in the PTFI stream numbering system used to track geological reconnaissance.

The site consisted of lowland primary alluvial forest in basins adjoining the main river that changed into a drier, better-drained lower hill forest on the adjacent slopes. There was little indication of human disturbance either in the field or from the landsat image. Terrestrial work was largely confined to forest on the north side of the river no more than 3 km from the camp and ascending no more than 150 m elevation.

Wapoga Alpha Camp.
3° 08.687' S, 136° 34.423' E. Elevation: 1070 m a.s.l.
All taxonomic groups were surveyed at this site.

At this camp, several sampling drills operated earlier in 1998 and 1997, but had been recently abandoned. The surrounding forest was minimally impacted by the drilling operations except where trees had been felled to allow helicopter access to drill pads. The survey area spanned the transition from hill forest to lower montane forest. The soil is probably rather nutrient poor and consequently there is little evidence of human occupation in the area.

The headwater reach of the Ziwa River flows roughly south to north by the Wapoga Alpha drilling camp, and is split into two catchment basins of nearly equivalent size. These upper basins cut V-shaped canyons into an area of rugged ridges formed along the contact zone between Tertiary volcanic formations (consisting of andesites and pyroclastics with intrusions of diorite), and the Eocene central Irian ophiolite belt. The river runs almost entirely through the volcanic belt. The bed profile in this upper section is extremely steep, consisting of alternating cascades over bedrock exposures and rapids strewn with large volcanic boulders. Aquatic surveys were made along the main river and associated steep, rocky tributaries in the vicinity of Wapoga Alpha Camp.

Terrestrial work was conducted mostly along the southern/eastern side of the river ascending no more than 150 m elevation. The network of trails made by the exploration geologists were ideally suited for accessing forests in the area. Distinct changes in vegetation were apparent along the elevation change from roughly one km downstream (north) of the camp to the furthest drill site about 2 km upstream (south) of the camp. Around the camp, the forest was dominated by *Agathis* (Araucariaceae) emergents whereas at the highest reach of the trail to the south, *Agathis* appeared to decrease in dominance and the forest became noticeably moister with more epiphytic growth. Whether the *Agathis* forest is widespread, a mosaic, or confined to a narrow elevational band could not be determined on so short a visit.

To the south at the lowest elevations visited, the forest was more typical hill forest; thus the camp seemed to sit at the transition zone between two vegetation zones. Notable differences in the flora and avifauna could be observed from the lower part of the survey area to the higher part, a difference of only 200 m elevation. Epiphytic growth was not so dense as might be expected at this elevation, suggesting the area is relatively dry. On the basis of the local topography, the site could lie within a rain shadow. The area would be expected to have nutrient-poor soils due to the kind of parent rock substrate (Freeport geologists, personal communication). Apparently the area has had no recent human inhabitants— there is no evidence of gardens visible from the air and during the long period that Freeport geologists worked here, no local people visited their camp.

Such truly uninhabited areas are unusual in New Guinea and usually occur where soils are too poor to sustain gardens.

Helipad 55

3° 26.527' S, 136° 28.365'E. Elevation: 1890 m a.s.l.
Most terrestrial taxa (vegetation, birds, mammals, amphibians and reptiles) but no aquatic taxa were surveyed at this site.

This is the site of a helipad formerly used by Freeport exploration geologists. The site was on the flank of a steep mountain in primary montane forest. A narrow trail cut by exploration geologists led to much mossier and lower stature upper montane forest at approximately 2000 m a.s.l. on a ridgetop above the helipad. Here the trail descended steeply and the dense, deep root mat made further movement uphill difficult. The site was usually cloaked in dense fog, often obscuring much of the forest canopy from view. The extremely steep terrain and thick undergrowth in many areas restricted movement by the scientists.

The underlying rock at Helipad 55 was Eocene metamorphics, different from other sites in the RAP survey further to the north. The valley below the site was fairly densely populated by people who have had limited contact with the outside world. Due to the attenuation of aquatic diversity at high elevations in New Guinea, the aquatic scientists did not visit this site.

CHAPTER 2

TREES OF THE WAPOGA RIVER AREA, IRIAN JAYA, INDONESIA

Colin E. Ridsdale

Chapter Summary

- Approximately 430 species of woody vascular plants were collected during the survey.
- The vegetation of the area as a whole is intact with negligible anthropogenic disturbance.
- There have been no previous botanical collections from this area, which makes the RAP collections very important.
- Four plant collections probably represent undescribed taxa, and others represent major range extensions or taxa previously known only from a few collections.
- Further botanical work is required, preferably at a different time of year when the vegetation is flowering.
- Further study of the blackwater swamp forest at Siewa is desirable as there is no information available regarding this vegetation type.

Ringkasan Bab

- Kurang lebih 430 spesies tumbuhan berpembuluh dikoleksi selama survai.
- Vegetasi dilokasi secara keseluruhan masih utuh dengan campur tangan manusia yang dapat diabaikan.
- Belum ada koleksi botani dari lokasi ini, sehingga koleksi RAP menjadi sangat penting.
- Empat koleksi tumbuhan barangkali mewakili taksa yang belum pernah dideskripsikan, dan yang lainnya mewakili taksa dengan penyebaran yang meluas atau taksa yang sebelumnya hanya diketahui dari koleksi yang sedikit.
- Penelitian botani yang lebih mendalam sangat dibutuhkan, khususnya pada saat yang berbeda dalam satu tahun ketika vegetasi sedang berbunga.
- Penelitian lebih lanjut mengenai hutan rawa air hitam di Siewa sangat dibutuhkan karena belum ada informasi yang ada mengenai jenis vegetasi ini.

INTRODUCTION AND METHODS

A botanical reconnaissance of the study area was conducted between April 3 – 21, 1998 by Dr. Colin E. Ridsdale (CER) from Leiden, Netherlands and Dr. Johanis P. Mogea (JPM) from the Bogor Herbarium, Bogor, Indonesia. Due to logistical restraints of helicopter transport no technical assistants were available and field assistance was obtained, when feasible, from the pool of three camp helpers.

Surveys were conducted at three sites: Siewa Base Camp (80 m), Wapoga Alpha Camp (1070 m), and Helipad 55 (1890 m). The time and number of collections at each site varied greatly, again influenced by logistical arrangements (see Appendix 1). At Helipad 55, collecting was possible on five consecutive days, often limited to a few hours, as heavy rain and dense, low, canopy-level cloud made fieldwork difficult. The majority of the period (ten days) was spent at the Wapoga Alpha Camp. Unfortunately, only one day was spent collecting in the environs of the Siewa Base Camp where a small sample was obtained from one habitat, the blackwater swamp forest.

Exploration and collections were made from the base camp areas. Generally there were no established forest trails, the exception being Wapoga camp where extensive trails had been established to the drilling sites. Some division of tasks between the two collectors was made, CER concentrating on the tree flora, JPM on the palms and lower strata, herbs and fern flora (see Mogea, this volume). All material thought to be covered by CITES regulations were collected in the number sequence of JPM for disposition in the Bogor Herbarium, Bogor, Indonesia. Visual observation of the canopy layers to isolate fertile material was assisted by scanning with binoculars, working from open edges or gaps where possible. Fertile specimens were collected in the field, bundled and preserved in alcohol. The material was then forwarded to the P.T. Freeport Environmental Lab in

Timika where the material was dried. Later this material was transported to the Bogor Herbarium. One set of the material collected by CER was then forwarded to the Rijksherbarium in Leiden, pre-identified, and the labels returned to Bogor for the subsequent sets. An attempt was made to collect multiple sets, up to five, for most taxa. Duplicate sets will be distributed from Bogor (see Mogea, this volume).

RESULTS AND DISCUSSION

A complete list of the botanical collections made by CER and deposited at the Rijksherbarium, Leiden is given in Appendix 2. As there was considerable difference in the elevations of the three sites, there is little overlap in the floral composition, except in the rheophytic vegetation along the fast flowing rivers which was dominated by one species, *Ficus arbuscula*, at Siewa Base Camp and Wapoga Alpha Camp (Appendix 2).

Helipad 55 (approximately 1890 m)

The montane vegetation was sampled at Helipad 55 at an altitude of 1900 m. The site was situated on an exceedingly steep slope and forest trails were absent. It was only possible to collect a small sample of the vegetation at this site. A large stilt rooted species of *Pandanus* was common in open patches in the area. The canopy was at about 20m, the dominant trees with an average dbh of 25 - 35 cm. The larger trees carried heavy loads of epiphytic vegetation, ferns, mosses and orchids. Surprisingly there seemed to be very low numbers of Ericaceae, including *Vaccinium*. *Gaultheria* (CER 2501) was the commonest of these. The dominant fertile large trees collected were Elaeocarpaceae, *Myristica* sp. *Pittosporum* sp., *Prunus* sp. The subcanopy contained typical montane taxa such as *Polyosma*, *Sphenostemon* whilst the understory contained *Octamyrtus* sp., *Saurauia* and *Zygogynum calothyrsum*. No representatives of Fagaceae or Lauraceae were collected. The presence of an unidentified species of *Dubouzetia* (Elaeocarpaceae) is interesting (see Appendix 3). An unidentified palm, not seen at the collecting site, dominated many ridges.

The ground layer was considered to be rich in ferns and bryophytes, but generally this layer and the understory had a very low diversity in higher plant taxa. The valley areas below the camp were sparsely populated with some low impact swidden agriculture.

Wapoga Alpha Camp (1070 m)

The lower montane area around the Wapoga drilling site was the site where the majority of the plant collecting activities took place. Unfortunately, we were not present in the flowering and fruiting season, and few plants were in a fertile condition.

The vegetation of the valley bottom along the rivers near Wapoga Alpha Camp was frequently dominated with *Garcinia* sp. Other tree components were *Gordonia amboinensis*, Lauraceae (*Cryptocarya*, *Litsea* spp.), *Myristica subulata*, *Neonauclea lanceolata*. It is probable that this zone is important as a food source for frugivorous birds and mammals as many of the taxa found in this zone produce fleshy fruits. The seeds of *Garcinia* sp. were frequently observed in the fresh droppings of the cassowary. The tree was obviously one of its major food sources at the time of the expedition. Within this zone two cauliflorous species were also found, *Goniothalamus* sp. and *Pseudobotrys cauliflora*. The ground layer was rich in Zingiberaceae.

The forest on the lower hill slopes adjoining Wapoga camp had a tall canopy at 20 - 30m in places dominated by *Agathis*, the larger trees with a dbh of 1.5 - 2m. Other large trees collected were *Bruinsmia styracoides*, Myrtaceae, Fagaceae, Lauraceae, and *Dysoxylum latifolium*. The latter was one of the few canopy trees consistently observed with heavy epiphyte loading on the higher branches. In general, epiphytic vegetation was poorly developed in this area. This forest on the lower slopes gradually merges into a low stature pole forest on the ridges and other higher areas. The forest clearance in the construction of the drilling sites gave clear views of the forest edge, but very few plants were flowering. An interesting find was a beautiful palm, *Licuala* sp., with one plant bearing ripe fruits, which were collected for the Botanical Garden in Bogor. The impression obtained walking through this forest was of low species richness, however this may have been a false impression. Surprisingly, there were undescribed taxa in the genus *Myristica,* a widely collected genus that has recently been revised, and in *Zygogynum*, where two unidentified new species were found. It is possible that the understory Rubiaceae also contain interesting taxa, particularly *Timonius*.

Siewa Base Camp (80 m)

The lowland forest around the Siewa Base Camp was most interesting. It is unfortunate that more time was not available for sampling the area. As far as we could ascertain two habitats existed, the lowland blackwater swamp forest, and a lowland forest in the non-swampy areas. The latter area was dissected with fast flowing rivers, the banks dominated by the flat-topped rheophytic *Ficus arbuscula*. The remaining areas of non-swampy forest were not sampled. Many trees of the swamp forest area were in flower at the time of our visit. Swamp forest has never been considered to have commercial potential for exploitation and hence was not investigated by the former forestry departments. There are a few isolated records of such forest in Irian Jaya but there are no detailed reports or botanical collections specifically from this type of forest. As such this forest formation should be a high research priority.

Botanical and Conservation Significance of the Area

Botanists are often at a great disadvantage in that botanical specimens usually must be fertile before accurate identifications can be made. In addition, species-rich plant groups, with numerous local taxa, are frequently found in large plant families where little taxonomic work has been performed. This was the case in the present collections. The lack of specific identifications is indicative that the collections usually do not represent common, widespread, easily identifiable species. The fact that no collecting has previously occurred in the area further restricted our ability to make even provisional determinations of sterile material collected on the survey. Some botanical collections have previously been made by Kanehira at Nabire, but likely from different vegetation types.

As far as I am aware, the present collections from all sites are the first to be made from this region of Irian Jaya. Clearly, only a small fraction of the flora is represented in the present collection. Approximately 190 botanical collections were made during the RAP survey by CER and about 269 were collected by JPM. The most interesting discoveries have been summarized in Appendix 3. The present collections represent such a small sample of the vegetation that it is very difficult to draw any concrete conclusions. However, enough novelties were found to indicate this area urgently requires more intensive inventory efforts. The forest formations at all camps were not "typical" or easily categorized as similar to other, better-studied sites. To the extent that this indicates unique vegetation formations in the area, or simply reflects inadequate floristic inventories throughout much of Irian Jaya, cannot be stated with confidence.

CHAPTER 3

UNDERSTORY PLANTS AND PALMS OF THE WAPOGA RIVER AREA, IRIAN JAYA, INDONESIA

Johanis P. Mogea

Chapter summary

- 269 collections of palms and understory plants were made: 3 from Siewa Base Camp (80 m), 167 from Wapoga Alpha Camp (1070 m), and 99 from Helipad 55 (1890 m).
- Of these, 32 collections of shrubs and herbs have been identified to species and 24 collections of palms were identified.
- Most of the collected palms were new specimens for the Bogor Herbarium. The tree *Licuala* sp. (JPM 7178 and 7196) may be a new species.

Ringkasan Bab

- Diperoleh 269 koleksi palem dan tumbuhan bawah tajuk: 3 dari Base camp Siewa (80m), 167 dari Camp Wapoga Alpha (1070m), dan 99 dai Helipad 55 (1890m)
- Dari jumlah tersebut, 32 koleksi semak dan perdu serta 24 koleksi palem telah diidentifikasi sampai tingkat spesies.
- Kebanyakan dari palem yang dikoleksi merupakan spesimen baru untuk Herbarium Bogor. Palem *Licuala* sp. (JPM 7178 dan 7196) kemungkinan merupakan spesies baru

INTRODUCTION AND METHODS

Field survey and botanical collections were made 4 -18 April 1998 at three sites during the RAP survey: Siewa Base Camp (80 m), Wapoga Alpha Camp (1070 m), and Helipad 55 (1890 m; see Appendix 1 for sampling schedule). I mainly collected palms, but also collected herbs, treelets, lianas, ferns, lichens, and mosses for herbaria preservation. Dr. C.E. Ridsdale collected mainly large trees.

At Helipad 55, afternoon rains and fog limited field time. The area was slippery and very steep, making exploration rather difficult. Observations were made following paths made through the forest in different directions from the base camp. The paths were not straight transects but followed whatever route was passable. Paths used as transect lines were on average 200 m long with area of observation about 10 m to the right and 10 m to the left along the path. The altitude covered was about 2300 - 2500 m.

At Wapoga Alpha Camp, rains were still frequent but much less compared to Helipad 55. The area was not steep, therefore the exploration was comfortable and hence rather intensive. There were some existing paths to old helipads and drill sites that were followed for about 4 km every day with an area of observation 20 m on either side. The elevation covered was about 900 - 1300 m.

In the field, the collections were processed following the techniques of plant collecting and preservation in the tropics introduced by Steenis (1950). In preparing the specimens for mounting, five duplicates have been made for each number of collection. Specimens will be deposited in herbaria of Manokwari, Bogor, Leiden, Kew, and other interested institutions.

RESULTS AND DISCUSSION

During the RAP survey, I made and cataloged a total of 269 plant collections: 167 collections from Wapoga Alpha Camp, 3 from Siewa Base Camp, and 99 from Helipad 55. So far, 32 collections of shrubs and herbs have been identified to species by my colleague Mr. Wardi from the Bogor Herbarium in Bogor, Indonesia and 24 collections of palms have been identified by myself (Appendix 4 and 5). Other collections are presented in a very superficial preliminary field identification format (Appendix 4). Below are some

general observations on the flora of the three survey sites. Locations and notes on the palm flora of Irian Jaya are based mainly on accounts of the collections and literature studied in Bogor, Indonesia.

Helipad 55 (1890 m)
Almost all surfaces, from the ground to tree branches were covered by mosses. From this area eight numbered collections of mosses were made. *Cyathea* sp. (JPM 7020) may be the dominant tree fern. Climbing epiphytic and terrestrial ferns were plentiful. About 37 collections of ferns were made. Other shrubs included *Psychotria leptothyrsa* (6905, 7055), *Galearia celebica* (7061), *Saurauia* spp. (6907, 7012), *Rubus moluccanus* (7011), *R. rosifolius* (7081), *Polyosma integrifolia* (7030), *Medinilla rubrifructus* (7042), *Polygonum chinense* (7066), *Anaphalis hellwigii* (7074), *Colubrina asiatica* (7077), *Elatostema* sp. (7078). Orchids were not numerous and only seven specimens were collected. From this area a collection of *Nepenthes* sp. (7044) and *Balanophora papuana* (7043) are rather unique. Other dominant herbs included species in the genera *Elettaria, Amomum* and *Hornstedtia* of the ginger family.

Wapoga Alpha Camp (1070 m)
The most notable vegetation at this site included a small population of an interesting primitive tree *Phyllocladus hypohyllus* (6938, 7150), as well as individuals of *Podocarpus* sp. (7134), and *Agathis damara* (7135). One understory tree, *Licuala* sp. (JPM 7178 and 7196), may be a new species. Other trees included *Garcinia* sp. (7184), *Elaeocarpus* spp. (7185, 7202), *Dysoxylum* sp. (7189). Shrubs which were collected from the area included *Psychotria leleana* (6947), *Psychotria* sp. (6927), *Tarenna fragrans* (7095), *Tarenna* sp. (7153), *Ixora* sp. (7199), *Urophyllum arboreum* (6951), *Ficus* sp. (6957), *Procis pedunculata*, *Medinilla auriculata* (7169a), *M. malabatrichum* (7169b), *M. boemiensis* (6931, 7168), *Medinilla* spp. (7171, 7190, 7197), *Eupatorium riparium* (7172), *Piper estonii* (6932), *Vaccinium* spp. (7108, 7132, 7148), *Saurauia* sp. (7113), *Ardisia* sp. (7118), *Schefflera* sp. (7144), *Sarcandra glabra* (6950), the climbing bamboo *Dinochloa* sp. (7109), the liana *Smilax leucophylla* (6930), *Smilax* sp. (7147), *Pothos latifolius* (7200), *Aeschynanthus* sp. (7165), *Hoya* sp. (7191), and *Aristolochia tagala* (7204). As at Helipad 55, the ginger family was very dominant. Herbs were numerous, including *Holamomena propinqua* (7160), *Caladium* sp. (7162), *Phrynium* sp. (7163), *Holochamys beccarii* (6938, 6946), *Cryptocorine* spp. (6948, 7170), *Elastostema* sp. (7174), *Cyperus* sp. (7105), *Dianella* sp. (7146). *Begonia isoptera* (7089), *Begonia hispidissima* (7164), *Begonia* sp. (7110), and *Cyrtandra* sp. (6933, 6939). Orchids were more frequent than at Helipad 55. At least 14 epiphytic and terrestrial orchids (e.g., *Phajus* sp., 6941) were noted. The epiphytic and terrestrial ferns were still very dominant; about 22 collections of ferns are made.

Siewa Base Camp (80 m)
Due to limited time at this site, only three plant collections were made. These included *Borassus heineana* (Arecaceae), and *Begonia weigalii* (Begoniaceae).

Remarks on the palm flora
The palm flora seemed rich in the lowland forest at the Siewa Base Camp, however there was insufficient time to adequately survey the area. At the Siewa Base Camp, the palm *Borassus hieneana* was collected with ten ripe seeds. The seeds are growing well at the moment in Bogor and it will be the first living collection of the species for the Bogor Botanical Garden. Herbarium specimens of this species are the second collections from Irian Jaya for the Bogor Herbarium. The first collections were only recently collected by McDonald and Ismail in 1992. The palms at the Wapoga Alpha Camp were quite numerous (16 taxa). At Helipad 55, the palm flora was very limited; only one *Calamus* sp.1 (6902) was found. In total, 24 palm collections were made, representing 17 taxa from six genera, namely *Areca, Borassus, Calamus, Calyptrocalyx, Gronophyllum,* and *Orania.* A full description of the palm genera, species, and collections is given in Appendix 5.

CONCLUSIONS

In total, 269 collections of understory plants were made during the RAP expedition to the Wapoga area (including 24 collections of palms). The ginger family and ferns were dominant at Helipad 55 and Wapoga Alpha Camp. At Helipad 55, mosses were particularly rich (8 taxa or more). Colorful orchids and other herbs with ornamental potential such as *Begonia*, *Aristolochia*, and *Cyrtandra* were found quite commonly at Wapoga Alpha Camp. The tree *Licuala* "arborea" (JPM 7178 and 7196) may be a new species and hence is in needed of further study.

Due to the lack of fertile specimens for most collections, identification to the species level has not been made for most species, particularly mosses and ferns. Most of the collected palms are new specimens for the Bogor Herbarium and are currently recognized as belonging to17 taxa. Only five of the palms have been identified to species, namely *Areca macrocalyx* (JPM 6918 and 7161), *Borassus heineana* (JPM 7207 and 7208), *Gronophyllum micranthum* (JPM 7097 and 7179), *G. pinangoides* (JPM 6943 and 7194), and *Orania lauterbachiana* (JPM 6916 and 7098). Further study of the understory and palm flora of the Wapoga Area is definitely needed in order to form a more complete picture of the vegetation of this unique region.

CHAPTER 4

AQUATIC INSECTS OF THE WAPOGA RIVER AREA, IRIAN JAYA, INDONESIA

Dan Polhemus

Chapter summary

- Aquatic insects were sampled at 18 stations in the Wapoga River drainage.
- A total of 110 species or distinct morphospecies were collected.
- Among these were 6 Coleoptera, 80 Heteroptera and 25 Zygoptera species.
- At least 38 species (35%) represent species new to science.
- The Wapoga River Basin contains an aquatic insect biodiversity similar to that of catchments previous surveyed in New Guinea.
- The Wapoga River Basin is a faunal intersection zone, where taxa typical of the Foja and Van Rees Mountains mingle with others characteristic of the central ranges.
- The Wapoga River system, particularly in its upper reaches, is a notable center of regional endemism and biodiversity for aquatic insects.

Ringkasan Bab

- Serangga air di sampling pada 18 stasiun di DAS Wapoga.
- Sejumlah 110 spesies atau spesies yang beda bentuk berhasil di koleksi.
- Diantaranya terdapat 6 Coleoptera, 80 Heteroptera, dan 25 spesies Zygoptera.
- Paling tidak 38 spesies (35%) merupakan spesies baru.
- Cekungan Sungai Wapoga memiliki keanekaragaman serangga air yang serupa dengan survey di Nugini (PNG).
- Cekungan Sungai Wapoga merupakan kawasan persilangan fauna, dimana taksa khas pegunungan Foja dan Van Rees bertemu dengan karakter lainnya yang berasal dari kawasan tengah.
- DAS Wapoga, terutama di bagian hulunya, tercatat sebagai pusat endemisme regional dan keanekaragaman bagi serangga air.

INTRODUCTION

The RAP surveys were intended to provide an initial biodiversity profile of aquatic insects in the Wapoga River catchment, in conjunction with ongoing conservation and land use planning initiatives in Irian Jaya. As with the previous aquatic insect surveys undertaken in the Ajkwa River basin (Polhemus and Polhemus *in press*), the primary groups surveyed for this project were aquatic Heteroptera (true bugs), Zygoptera (damselflies), and Gyrinidae (whirlygig beetles). These groups were chosen due to their consistency of representation across the range of habitats sampled, variation of species assemblages in response to altitude and habitat type, and relatively well investigated taxonomy. These three factors allowed confidence that identifications could be made to at least the genus level and reduced the potential number of undescribed species to be dealt with. Collections of other groups, such as Dytiscidae (predaceous diving beetles), Ephemeroptera (mayflies), and Trichoptera (caddisflies) were also made on a sporadic basis as opportunity permitted, but these taxa were not surveyed comprehensively.

METHODS

In order to provide an initial indication of the catchment's aquatic insect biodiversity, brief intensive surveys were made in the Wapoga River Basin at four of the five RAP survey sites (all except Helipad 55, see Appendix 1). Eighteen stations were sampled for aquatic insects from 3 to

22 April 1998. Physical parameters of each collecting station are described in Appendix 6. Heteroptera, Zygoptera, and Gyrinidae were collected intensively at each sampling station, and the listings given in the subsequent appendices should be considered relatively comprehensive. Other taxa, Dytiscidae, Ephemeroptera, and Trichoptera are occasionally reported in Appendices, but these listings should not be considered comprehensive for any given site.

Collections were made by visual searching, hand netting, and localized pyrethrin fogging of riparian logs and hygropetric habitats. Familiarity with the ecology of the groups involved was a prerequisite for such survey protocols, since many of the species inhabit particular circumscribed microhabitats not intuitively obvious to a non-specialist.

The specimens of aquatic Heteroptera and Coleoptera obtained were preserved in 75% ethanol, then transported to the Smithsonian Institution for detailed analysis and identification. Odonata were also preserved in alcohol, a method that provides better short term preservation of color patterns, is immune to attack by ants and fungus, and allows for the possibility of subsequent molecular systematic analysis of the specimens. Duplicate samples were subsequently segregated from the alcohol lots, treated in acetone, and stored dry in glassine envelopes. Identifications of taxa collected were made primarily by the author, with significant assistance on aquatic Coleoptera and Trichoptera from Drs. Paul Spangler and Oliver Flint respectively, both from the Smithsonian Institution, Washington, D. C. Voucher specimens from the collections obtained during the course of these surveys will eventually be deposited in the Indonesian Institute of Sciences (LIPI), Cibinong; the Smithsonian Institution, Washington, D. C.; and the Bishop Museum, Honolulu, Hawaii.

RESULTS

Collections made during the RAP survey in the Wapoga River drainage contained 110 species or distinct morphospecies of aquatic insects in groups targeted for intensive survey, including 6 species of Coleoptera (Gyrinidae), 80 Heteroptera and 25 Zygoptera. Of these, at least 38, or 35%, represent species new to science, including 36 new species and two new genera of Heteroptera as well as two species of Zygoptera.

Appendix 7 provides listings of the aquatic insect species captured at each sampling station. In many cases the taxa encountered could be identified to species. When specific determination was not possible, notations are made for species that are considered new to science, species that could not be determined and which might be new, and species that could not be assigned to a genus. In all cases, specimens are assigned to morphospecies to enable comparisons among the collecting sites. Heteroptera were the most diverse; there was an average of 11.30 species of Heteroptera, 3.00 species of Zygoptera and 0.88 species of Gyrinidae per station among the eighteen sampling stations (Appendix 7). A combined checklist of all taxa captured across major ecological zones and a summary of species numbers taken at each station are included in Appendix 7.

DISCUSSION

The island of New Guinea represents the northern margin of the Australian continental plate, which has collided over the last 40 million years with several southward migrating volcanic arcs. The largest of these arcs was sutured to the island in the Eocene, forming the ophiolite and metamorphic belts of the central mountains. Certain Tertiary volcanic formations lying immediately to the north of these belts are probably also associated with this arc. Later, in the Miocene, a second set of arc terranes was attached to the northern margin of the island, forming the northern coastal ranges.

The Wapoga River catchment lies in the geological suture zone between these two arcs, occupying a depression between early Tertiary volcanic formations abutted against the central Irian Jaya ophiolite belt to the south, and the uplifted Pliocene shales and other mixed sediments that form most of the Foja and Van Rees Mountains to the north. This zone appears to be a western continuation of the same structural trough that contains the Mamberamo River further to the east, as well as the Sepik, Ramu, and Markham rivers of Papua New Guinea. In a topographic sense this trough represents the boundary between the central and north coastal ranges of Irian Jaya. As such, the Wapoga Basin is a faunal intersection zone, where taxa typical of the Foja and Van Rees Mountains mingle with others characteristic of the central ranges.

The location of the Wapoga Basin complicates interpretation of its biota. It is difficult to know, for instance, whether new species from this area represent taxa endemic to the western section of the central ranges, or to the Van Rees Mountains, or to both areas in combination. Samples at hand from areas further east on the northern slope of the central ranges, in drainages flowing to the Mamberamo, show limited taxonomic overlap with the samples from the upper Wapoga. This evidence, coupled with the fact that many of the taxa taken in the Wapoga Basin are distinctive new taxa, indicates that the samples from this area are most likely representative of an endemic Van Rees Mountain biota.

As with all river systems in New Guinea that traverse a broad range of elevations, the Wapoga system displays an obvious faunal zonation as one moves upstream from the mouth to the headwaters. The initial aquatic insect surveys

indicate that a distinct elevational zonation exists in regard to the biota, with particular elevational zones supporting distinctive assemblages of Zygoptera and aquatic Heteroptera. Zones that can be clearly identified based on current surveys include lowland swamp forest, lowland rain forest, premontane foothills, and lower montane. These zones correspond to the four main collecting regions (lowland swamp forest: Lower Wapoga River, lowland rain forest: Tirawiwa River, premontane foothills: Logari River and lower montane: Ziwa River) as noted in Appendices 6 and 7. Each zone can be defined by certain signature taxa as follows:

a.) Lowland swamp forest, 0–15 m.: *Rheumatometroides* n. sp., *Hydrometra* sp. undet. #1, *Ochterus* n. sp. #3, *Nososticta* sp. undet. #3 (nr. *erythrura*).

b.) Lowland rain forest, 50–100 m.: *Gyrinus* sp. undet., *Micronecta* sp. undet., *Iobates affinis*, *Limnometra ciliata*, *Hydrometra lineata*, *Aptinocoris sedlaceki*, *Ranatra megalops*, *Ranatra diminuta*, *Cercotmetus dissidens*, *Enithares loria*, *Microvelia* sp. #1, *Microvelia* sp. #7, *Rhagovelia* sp. #1, *Rhagovelia* sp. #2, *Agriocnemus aderces*, *Pseudagrion farinicolle*, *Pseudagrion ignifer*, *Lestes tenuissimus*, *Nososticta beatrix*.

c.) Premontane foothills, 100–500 m.: *Mesovelia subvittata*, *Ochterus* n. sp. #2, *Rhagovelia* n. sp. #9, *Microvelia* n. sp. #3, *Microvelia* n. sp. #8, *Microvelia* n. sp. #9, *Microvelia* n. sp. #10.

d.) Lower montane, 500–1000 m.: *Spinosodineutes* sp. undet., *Ptilomera* n. sp. #2, *Nesocricos* sp. undet., *Tanycricos* n. sp. #1, *Tanycricos* n. sp. #2, *Ochterus* n. sp. #4, *Ochterus* n. sp. #5, *Rhagovelia* n. sp. #5, *Rhagovelia* n. sp. #6, *Microvelia* sp. #6, *Aegilipsicola* n. sp., Microveliinae n. gen. and sp., *Rhagovelia* n. sp. #5, *Rhagovelia* n. sp. #6, *Rhagovelia* n. sp. #7, *Rhagovelia* n. sp. #8, *Teinobasis scintillans*, *Argiolestes* n. sp. #3, *Drepanosticta* sp. nr. *clavata*.

In general, it was found that the main river channels below 100 m presented a uniformly harsh environment with a limited aquatic insect biota. The guild of surface dwelling insects found here was reduced from that of smaller tributary streams, typically consisting of Heteroptera such as *Ptilomera* water striders and riffle bugs in the *Rhagovelia caesius* group, the latter of which naturally prefer open, unshaded waters. By contrast, the most diverse sites visited during the current survey were overflow channels bordering the Tirawiwa River at 65 m elevation, and the smaller rivers and tributaries of the mountain zones between 300 and 1000 m (see summation of number of species captured at the bottom of Appendix 7).

The collections obtained during the RAP survey are highly significant, since they originate from an area never previously visited by scientific parties, and fill a major gap in our distributional and taxonomic knowledge of aquatic insects in northern Irian Jaya. Although some previous logging activity has occurred, the sections of the Wapoga River catchment studied during the course of this survey still present a nearly pristine aspect. The current mineral exploration activities of P. T. Freeport Indonesia are restricted to small and widely scattered exploration and drill sites and appear to have had little or no impact on the overall aquatic insect biodiversity of this area.

Comparisons to previous studies

Two previous comprehensive river basin studies for aquatic insects have been undertaken in New Guinea, to which the current findings may be compared. The first of these was the Field Survey of Biodiversity conducted by the World Wildlife Fund and associated specialists in the Kikori River Basin of southern Papua New Guinea in March 1995 (Polhemus 1995). The second was a survey of the Ajkwa River basin near Timika, Irian Jaya, Indonesia (Polhemus and Polhemus *in press*). These surveys covered transects through similar elevational ranges (Table 4.1.), and their results provide a reasonable basis for comparison to the recent surveys in the Wapoga River Basin. Average sampling time was 3.40 man hours per station in the Wapoga River basin, versus 3.28 man hours in the Ajkwa and 4.40 man hours in the Kikori (Table 4.1.). The sampling in the Wapoga catchment was thus of relatively equivalent intensity, but took place at fewer sites and over a slightly smaller elevational range.

Table 4.1. Comparison of sampling effort on three comprehensive surveys of aquatic insects in New Guinea.

Survey area	Elevational range (m)	Length of transect	# Days sampled	# of stations	Avg. hours per station
Wapoga[1]	0-1050	120 km	20	18	3.40
Ajkwa[2]	0-2100	100 km	28	33	3.28
Kikori[3]	0-1500	200	25	33	4.40

[1] this study.
[2] Timika, Irian Jaya, Indonesia, see Polhemus and Polhemus *in press*.
[3] Southern Papua New Guinea, see Polhemus 1995.

Comparative data on species captures in intensively sampled aquatic insect groups between the Ajkwa and Kikori transects are shown in Table 4.2. These numbers show that the Wapoga River Basin contains an aquatic insect biodiversity similar to that of previous catchments surveyed, being slightly more diverse than the Ajkwa and slightly less diverse than the Kikori. Notably, the number of aquatic Heteroptera species captured is the highest for any river basin so far sampled in New Guinea.

The number of new species was somewhat lower in the Wapoga basin than in the Ajkwa or Kikori, probably due to the longer history of scientific collecting on the northern coast of New Guinea. Many of the early entomological collections on the island were made by Bir— in the area around the German settlements at Madang, and a certain proportion of these taxa extend westward into the Wapoga system. At the same time, the degree of taxonomic overlap between Ajkwa and Kikori was approximately 30 percent (Polhemus and Polhemus *in press*), such that many of the new species found in one river basin were also seen in the other, whereas many of the new taxa taken on the Wapoga survey have been found nowhere else in New Guinea. This high degree of endemism marks the Wapoga system, particularly in its upper reaches, as a notable center of regional biodiversity.

Table 4.2. Species of aquatic insects captured in selected groups along the Wapoga, Ajkwa and Kikori transesects.

Numbers in parentheses indicate number of new species captured in given groups.

Survey area	Heteroptera	Zygoptera	Gyrinidae	Total
Wapoga[1]	78 (30)	24 (12)	5	107
Ajkwa[2]	65 (41)	27 (4)	5	97
Kikori[3]	75 (40)	36 (7)	6	117

[1] this study.
[2] Timika, Irian Jaya, Indonesia, see Polhemus and Polhemus *in press*.
[3] Southern Papua New Guinea, see Polhemus 1995.

CHAPTER 5

ANTS OF THE WAPOGA RIVER AREA, IRIAN JAYA, INDONESIA

Roy R. Snelling

Chapter summary

- Siewa Base Camp (65 - 80 m) and Wapoga Alpha Camp (1070 m) were surveyed for about two weeks each.
- A total of 223 individual ant samples were collected, comprised of 196 species in 52 genera (Siewa: 135 species, 47 genera; Wapoga: 96 species, 38 genera)
- Only 34 ant species (17%) were common to both sites.
- Sixteen ant species collected have not been previously recorded from Irian Jaya and thus represent first records for Indonesia.
- At least seventeen ant species belong to previously undescribed taxa, several of which are now being described based on these collections.
- The New Guinean ant fauna is probably far richer than has been previously thought.
- Additional survey work of ants in this area is clearly warranted.

Ringkasan Bab

- Base Camp Siewa (65-80 m) dan Camp Wapoga Alpha (1070 m) masing-masing disurvey selama dua minggu.
- Sejumlah 223 individu sampel semut dikoleksi, terdiri dari 196 spesies dari 52 genera (Siewa: 135 spesies, 47 genera; Wapoga: 96 spesies, 38 genera).
- Hanya 34 spesies semut (17%) yang umum dijumpai di kedua lokasi.
- Enambelas koleksi spesies semut belum pernah tercatat dari Irian Jaya sehingga menjadi catatan pertama untuk Indonesia.
- Kurang lebih tujuhbelas spesies semut berasal dari taksa yang belum pernah dideskripsikan, beberapa diantaranya sedang dideskripsikan berdasarkan koleksi tersebut.
- Fauna semut Nugini kemungkinan lebih kaya daripada yang diperkirakan sebelumnya.
- Survey lebih lanjut mengenai semut dikawasan ini sangat diperlukan.

INTRODUCTION

Ants and other social insects (bees, wasps, termites) comprise a signification portion of the total animal biomass in any tropical ecosystem (Davidson 1997, Wilson 1987). They are numerically abundant and are taxonomically more diverse than any other group of social organisms; in fact, more species and genera of ants were collected than in any family of any other group of organisms studied at the Siewa and Wapoga sites. Furthermore, since many are specialized predators, they may prove useful indicators of the ecological health of any given area.

Ants, social wasps, and spiders are the principal predators of other invertebrates in tropical ecosystems. While adults of both ants and social wasps feed largely, if not entirely, on plant exudates and are not, themselves, true predators, their larvae are carnivorous and adult ant and wasp predation on other organisms is for the purpose of providing food to their larvae.

Ants, in particular, are significant predators: (a) with few exceptions, all species of ants are opportunistic predators; (b) colonies are perennial, often with a large, permanent population of larvae to be fed; (c) various ant species are dispersed into every microniche, granting foragers rapid access to all manner of prey; (d) ants are generally capable of foraging under almost any conditions; (e) the taxonomic diversity within any ecological niche enables ants to exploit almost all available resources. On the other hand, ants themselves represent an almost unlimited food resource for other predators, including such

vertebrates as frogs, lizards, birds, bats, and other insectivorous mammals. They are also subject to predation by other invertebrates, including spiders, scorpions, predatory flies, and, perhaps most importantly, other ant species. The species of the ant genera *Cerapachys* and *Aenictus* are specialist predators on other ant species (Wilson 1959a, 1964).

METHODS

The site at the Siewa Base Camp (65 – 80 m) is in an area of lowland rainforest that had been intensively logged in places before my visit. In the area where ants were surveyed, some primary trees remain, but dense second growth had filled in due to the opening of the canopy from logging and logging roads. There was little ground litter. The sampling area was characterized as Open Rain Forest (sensu Wilson 1958): "Broken canopy; considerable ground insolation; leaf litter 2-15 cm thick; leaf mold present but thin and relatively dry; soil loose, well aerated and relatively dry; moss scarce on both ground and tree trunks." The Wapoga Alpha Camp site, an area of primary montane rainforest at 1070 m was a cooler - and wetter - site than Siewa and ant diversity there, both in genera and species, appears to be less than at Siewa.

Ants were opportunistically collected from prime microhabitats for ants, as determined by the experience of the collector. Ants were hand collected from standing vegetation and fallen (or cut) tree trunks; loose bark was pulled off and ants collected from under the bark as well as from rotting trunks and branches. Samples were also collected from under moss and in the root masses of epiphytes. Additional samples were taken of foraging ants in ground litter and from under objects on the ground. Winkler bags were used to extract ants and other arthropods from leaf litter. Extraction of arthropods using Winkler bags involves hanging mesh bags of leaf litter inside a large cotton bag. As the leaf litter dries out, ants and other small litter arthropods leave the leaf litter and fall to the bottom of the outer bag into a collecting cup of alcohol (see Fisher 1997 for details of the Winkler method). Finally, several Malaise traps were set up at each site. Malaise traps are essentially stationary nets that collect flying insects into jars of alcohol; they are an excellent method for securing the winged sexual forms of ants. Sometimes, too, they collect foraging ant workers that explore the nets for food. Hundreds of male ants, and a smaller number of females, were found in the Malaise trap samples; some represented species not otherwise collected.

RESULTS AND DISCUSSION

Preliminary results of my ant collections are listed in Appendix 8, showing the species present at both sites. Twenty-eight genera were present at both sites, but only 34 species were shared, two-thirds of which are taxa that inhabit the leaf litter. I have only begun the task of species level identification, but several undescribed species are present in the samples, as well as numerous significant range extensions.

Subfamily Aenictinae

One foraging column of *Aenictus huonicus* was collected at Siewa; one foraging and one emigration column of the same species were collected at Wapoga. No other worker *Aenictus* were collected. On the other hand, between the two sites, 5 species represented by males were collected, three at Siewa and two at Wapoga. Aenictinae are related to the New World Army Ants and the African Driver Ants and all are presumed to be specialist predators on other ant species (Wilson 1964). Although the systematics of New Guinean *Aenictus* (Wilson 1964), based on workers, is pretty well worked out, the classification of the males is very confused and none have been associated with their respective worker forms.

Subfamily Cerapachyinae

Only one clearly identifiable species of *Cerapachys* was found during the present survey, but the acquisition of three unidentifiable male species, indicates that clearly more species of these cryptic and elusive ants, are to be found. *Cerapachys* species are largely, if not entirely, predators of other ant species (Wilson 1959a).

Subfamily Dolichoderinae

Two dolichoderine genera were common at both sites: *Anonychomyrma* and *Leptomyrmex. Anonychomyrma* is a small genus of common arboreal ants. Colonies are very populous and are usually found within living plant structures, such as hollow stems and within domatia of such plants as *Myrmecodia*. The species are considered to be general predators; they also feed on plant juices (Shattuck 1999). One collection made at Siewa was from a living stem of *Steganthera* in which the ants were tending unidentified mealybugs (Homoptera).

Leptomyrmex species are long-legged, spidery ants that may be seen foraging in the litter and, sometimes, on low vegetation. Colonies seem to consist of no more than a few hundred workers and are situated in soil or dead wood. Although workers forage singly, they do recruit additional individuals at need.

Subfamily Formicinae

This subfamily is dominated by two highly species rich genera, *Camponotus* and *Polyrhachis*. In both genera species are mostly arboreal, usually nesting in dead wood on living trees. A few species of *Polyrhachis* weave nests of larval silk & leaves. All feed largely on plant exudates, either

directly or via various Homoptera; they are also opportunistic predator/scavengers. The one species of *Pseudolasius* collected lives within the bark of live trees and fosters mealybugs within chambers in the living bark. Species of *Paratrechina* are ubiquitous foragers in leaf litter and are largely scavengers as well as gatherers of plant exudates.

Subfamily Myrmicinae

This is the largest and most diverse subfamily collected, clearly dominated in our area by the genus *Pheidole* (20 species). Some species nest in ground or in rotten wood (whether on the ground or in low arboreal sites); a few are true arboreal species. These ants are general predators and scavengers and also feed on seeds. Another conspicuous lowland genus is *Crematogaster*; some species nest in rotting wood and others nest in hollows of living plants; these ants are also general predator/scavengers. Species in genera such as *Eurhopalothrix*, *Strumigenys*, and *Pyramica* nest in rotting wood or in leaf litter; they are mostly presumed to be specialist predators on selected groups of small arthropods or arthropod eggs. Other genera, such as *Oligomyrmex* and *Solenopsis*, contain species that nest in close proximity to nests of other ants or termites; they are assumed to be predaceous on these neighbors (Shattuck 1999). Virtually nothing is known of the biologies of such genera as *Lordomyrma*, *Myrmecina*, and *Pristomyrmex*.

Subfamily Ponerinae

The most conspicuous ponerines are the large, diurnal species of *Odontomachus* and *Rhytidoponera*. These are active predators, with caterpillars and other soft-bodied insects forming a large part of the prey taken. *Odontomachus* are capable of delivering a quite painful sting. Other genera (*Hypoponera, Pachycondyla, Ponera)* may actually be more abundant, but these are mostly litter-inhabiting species that are not usually very conspicuous. The few species of *Myopias* are specialist predators on millipedes.

Subfamily Pseudomyrmecinae

No species of *Tetraponera*, the only pseudomyrmecine genus known to be present on New Guinea, were found during this survey. These large arboreal ants are probably present there, however.

Although my original assessment was that the faunas of both sites are depauperate, such may not, in fact, be true. At Lakekamu, Papua New Guinea (PNG), over 250 ant species were collected in about 9 weeks of effort (Snelling 1998). During the first two weeks at Lakekamu a total of 109 species was collected from 111 samples. These results closely parallel those obtained at both Siewa and Wapoga, suggesting that the latter faunas might well prove much richer were more time available for survey work.

When compared with the results obtained by Wilson (1959b) at lower Busu River, PNG, much the same impression results: In about two months of collecting Wilson found 171 species in 51 genera compared to 134 species in 46 genera I collected at Siewa Base Camp during only two weeks of effort. These collections, both at Siewa and Wapoga, reinforce my impression that the New Guinean ant fauna is far richer than has been previously thought.

There were some interesting "gaps" in the samples. For example, the rare ponerine genus *Myopias*, was well represented at Lakekamu, another lowland forest site, and at Wapoga. No species were found at Siewa, the lowland site on the present survey. Since most species of *Myopias* are specialized predators on millipedes, which were common at Siewa, this is puzzling. Similarly, the genus *Crematogaster,* an often dominant element in tropical forests, with both ground-level and arboreal species, appears to be absent at Wapoga. Crematogaster species are known to occur in similar cool montane habitats in other parts of the world, including New Guinea. At both sites the species rich, largely arboreal genus *Polyrhachis* was much less diverse than I had expected. Obviously, the limited time available for this survey was a contributing factor and I expect that further collecting would correct these seeming absences.

No special effort was given to searching the Siewa Base Camp site for adventive, widespread ant species, and only three were found: *Tapinoma melanocephalum*, *Monomorium floricola* and *Tetramorium bicarinatum*. The very common tramp species, *Paratrechina longicornis*, was not seen and is assumed not to be present there. Also absent was *Anoplolepis gracillipes*, another widely distributed pest species throughout the Indoaustralian region. Both are aggressive foragers with large, populous colonies and are unlikely to have been overlooked had they been present.

Of the three introduced species that I did find at Siewa, both *T. melanocephalum* and *M. floricola* had successfully invaded forest areas where they apparently became quickly assimilated into the native mix; their presence did not seem to adversely affect other ant species there. This apparently benign situation probably would be reversed in the presence of continued disturbance of the habitat. *Tetramorium bicarinatum* was apparently limited to the immediate camp area and was found foraging in several of the structures there, especially in the mess hall.

A single introduced species, *Technomyrmex albipes*, was found at Wapoga camp, only in the immediate vicinity of the helipad. At the time of my visit there was no indication that this tropical Asian species had penetrated much beyond that site. This ant is generally regarded as a minor nuisance, but does foster scale insects and mealybugs in some situations; the potential does exist that it could result in some habitat disequilibrium.

A primary set of voucher specimens (including types) and all relevant notes, will be deposited in the Entomology

Section, Los Angeles County Museum of Natural History. A secondary voucher set will be deposited in the Museum Zoologicum Bogoriense, Bogor. Additional voucher samples, as available, will be deposited in the Australian National Insect Collections, Canberra; B.P. Bishop Museum, Honolulu; Museum of Comparative Zoology at Harvard University, Cambridge; and The Natural History Museum, London.

CONCLUSIONS

The Wapoga River Area is of considerable interest and I would hope that further surveys can be conducted to determine the true extent of the diversity of the ant fauna, as well as assess its relationships to the Papuan fauna further east and with other elements of the Malesian fauna to the west and north. Essential to such an effort would be comparative surveys in lowland primary forest adjacent to secondary forest in order to provide a base-line for determining the impact of logging and other disturbances on ant faunas. Such diversity evaluations would require a minimum time of two months at each site, although my experience at Lakekamu suggests that three months would be far more productive.

CHAPTER 6

FISHES OF THE WAPOGA RIVER SYSTEM, NORTHWESTERN IRIAN JAYA, INDONESIA

Gerald Allen and Samual Renyaan

Chapter summary

- The total freshwater fish fauna of the Wapoga River system collected during the RAP survey and reported herein consists of 46 species belonging to 34 genera and 16 families.
- The collections from the present survey include at least two new rainbowfish species, *Glossolepis leggetti* and *Melanotaenia rubripinnis* (Allen and Renyaan 1998), and an undescribed "sucker-goby" (*Sicyopterus*).
- The diversity of the Wapoga system fish fauna compares favorably with that of the much more extensive Sepik-Ramu system of New Guinea.
- The results of the RAP survey indicate the strong probability that the drainages flowing into eastern Cenderawasih Bay form a localized area of endemism within the Great Northern Province.

Ringkasan Bab

- Total fauna ikan dari DAS Wapoga yang dikoleksi selama survai RAP dan dilaporkan di sini terdiri dari 46 spesies dari 34 genera dan 16 famili.
- Koleksi dari survai yang sekarang termasuk didalamnya dua spesies ikan pelangi, *Glossolepis legetti* dan *Melanotaenia rubripinnis* (Allen dan Renyaan 1998), dan satu jenis "gobi-penghisap" (*Sicyopterus*) yang belum pernah dideskripsikan.
- Keanekaragaman fauna ikan DAS Wapoga sebanding dengan DAS Sepik-Ramu di Nugini.
- Hasil dari survai RAP menunjukkan indikasi kuat bahwa aliran sungai yang menuju Teluk Cenderawasih bagian timur membentuk daerah lokal endemik di dalam propinsi bagian utara.

INTRODUCTION

This report contains a comprehensive documentation of the fish fauna of the Wapoga River System of northwestern Irian Jaya, Indonesia. It is based solely on the RAP field survey conducted between April 3-20, 1998.

The principle aim of the survey was to provide a comprehensive inventory of the fish fauna of the Wapoga River system, with special emphasis on species that might be unique to this area. The results of this survey should prove useful in evaluating the overall conservation significance of the area. Survey results also permit direct comparison of the fish fauna with other river systems, both within and outside New Guinea.

Overview of the New Guinean freshwater fish fauna

Although the marine fishes of New Guinea are reasonably well documented (Allen and Swainston 1993), the same cannot be said of the freshwater fauna. Field surveys and published taxonomic works have been sporadic since the first species were discovered in the 1860s. Historically there have been considerable problems associated with fieldwork in the interior. Aside from the dangers of malaria and other diseases, potential collectors were discouraged by the hazards of overland travel across very difficult terrain. Consequently, most early collections were obtained near the coast or along navigable rivers. The most active period of ichthyological exploration occurred between 1903-1920 by Dutch naturalists. The majority of these early collections were summarized by Weber (1913). By 1925, a total of approximately 100 species had been recorded from fresh waters. These indicated a high degree of specialization and endemism in the freshwater fish fauna.

There has been a pronounced renewal of interest in the freshwater fauna during the past 25 years, in part due to the development of an efficient air transport network, as well as road construction in previously inaccessible districts. Most recent research has involved Papua New Guinea, the island's eastern half. Comprehensive surveys were conducted for the Fly, Purari, Laloki, Sepik, Ramu, and Gogol rivers, as well as many other regions (see Allen 1991 for a review). As a result of these investigations there now exists a fairly comprehensive knowledge of the fishes inhabiting the eastern half of the island. The known New Guinea freshwater fish fauna currently includes about 340 species.

Unfortunately, the western half, the Indonesian province of Irian Jaya, remains poorly studied (Allen 1996). Our knowledge of the fishes of this vast area is still largely based on the now out-dated work of the early Dutch explorers. Allen and Hortle (1998) have comprehensively sampled the Timika region and a provincial survey was initiated by the present authors in 1995, but most regions remain unsurveyed. The region of Irian Jaya that includes the Wapoga River and other systems draining into Cenderawasih Bay is typical of much of the province in that there has been no previous fish collecting activity.

The final tally for the entire island will perhaps approach 400 species or about twice the number known from nearby Australia. Although relatively small by world standards, the freshwater fish fauna of New Guinea is highly unique. The fauna contains about 40 families and is dominated by atherinoids (rainbowfishes, blue-eyes, and hardyheads), plotosid (eel-tailed) and ariid (fork-tailed) catfishes, terapontids (grunters), and gobioid fishes (gobies and gudgeons). These marine-derived families collectively account for about two thirds of New Guinea's entire fauna. The rainbowfishes (family Melanotaeniidae) and closely related blue-eyes (Pseudomugilidae) are of particular evolutionary interest. These two families contain 70 species, including 48 Irian Jaya-Papua New Guinea representatives; both families are endemic to Irian Jaya-Papua New Guinea and Australia (Allen 1991).

The New Guinean fauna is very similar to that of northern Australia. In fact, about 35 species are shared by these areas. This faunal link is not surprising considering that southern New Guinea is part of the Australian continental plate and the two areas were formerly connected by a land bridge as recently as 6000-8000 years ago.

Unlike other tropical areas such as Africa and South America, which are inhabited by numerous fishes that evolved entirely in freshwater, the species found in New Guinea and Australia, with only a couple of exceptions, are "secondary" freshwater forms. They were derived from marine fishes, which entered fresh water in relatively recent geologic times.

METHODS

Fishes were collected in the vicinity of four of the main camps utilized by the RAP team (fish were not surveyed at the highest camp, Helipad 55 (1890 m) because few fish would be expected at this elevation). Most of the effort was expended near the Siewa Base Camp (65-80 m) and additional collections were made in mountain streams at the Logari/Landing Site 21 (LS-21, 275 m), at the Wapoga Alpha Camp (1070 m), and in lowlands near the Wapoga River mouth at Wapoga Staging camp (10 m). These sites offered an excellent range of aquatic habitats including large turbid rivers, braided rocky streams exposed to sunlight, shaded rainforest creeks, muddy mangrove streams, swamps, and upland torrents. Descriptions of each site are in Appendix 9 and 12.

A variety of methods was utilized although rotenone and seine-netting were the primary means of procuring collections. Rotenone is a poison derived from the derris plant, and is ideal for collecting fishes in small creeks or sections of larger streams where current flow is minimal. The general method consisted of mixing approximately 0.5 - 1.5 kg of rotenone powder with several liters of water. This solution was then dispersed over a period of 5-10 minutes. After several minutes of exposure the stunned fishes begin to gasp at the surface and are easily netted. A seine net is generally used to block off the downstream end of the collecting area. Rotenone stations were frequently made in small creeks near their junction with larger streams. A representative, yet minimal sample of fishes are obtained in this manner, as the rotenone is quickly rendered inactive when diluted by the flow of the larger stream.

A 15 meter-long, fine-meshed seine was used in larger creeks and the edges of rivers. It has a width or "drop" of about 2.0 meters, is weighted with lead along the bottom edge, and has a number of floats on the upper edge. The best technique for using this type of net is with one person at each end. One person holds a more or less stationary position on the bank while the other wades out into the stream and then returns along a roughly u-shaped path, then both ends are quickly hauled ashore. A pair of small, hand-held scoop nets was effective for catching rainbowfishes and a few other species at night with the aid of a flashlight.

Fish specimens were initially fixed in a 10 percent formalin solution and later transferred to 75 percent ethanol for permanent storage in museum collections. Most of the material was deposited at the Museum Zoologicum Bogoriense, Bogor, Indonesia (MZB), and a small representative collection is lodged at the Western Australian Museum, Perth.

RESULTS AND DISCUSSION

Definitions

For the purpose of this report, a freshwater fish is defined as a species that either lives its entire life cycle in fresh water or is commonly found in this habitat as an adult. We have made subjective judgments for several species that live in the "gray" area where fresh waters mix with estuarine conditions. The recognition of these problematical species as freshwater inhabitants is largely based on personal experience from other areas. Hence their categorization is subject to change as more information on life history becomes available.

Certain biogeographic terms used in this report also require explanation. The term New Guinea refers to the entire island, consisting of both Irian Jaya and Papua New Guinea (PNG). Indo-Australian Archipelago includes the Philippines, Indonesia, New Guinea, Solomon Islands, Vanuatu, and northern Australia. Wapoga system encompasses the main Wapoga River and all of its tributaries.

The total freshwater fish fauna of the Wapoga River system reported herein consists of 46 species belonging to 34 genera and 16 families. An annotated list of species is presented in Appendix 10 and a summary list in Appendix 11. Most of the fishes appearing in the lists were discussed and illustrated by Allen (1991). The collections from the present survey includes at least two new rainbowfish species (Allen and Renyaan 1998) and an undescribed goby.

Overall faunal composition of the Wapoga River system

The freshwater fauna of the Wapoga River system is similar to other parts of New Guinea and northern Australia in that relatively few families dominate. As elsewhere in this region, groups such as rainbowfishes, gobies, and gudgeons are very common. Collectively, these groups account for 50 percent of the fauna. As far as total fish species richness is concerned the Wapoga is average compared to other New Guinea drainages (Table 6.1.). However, the relative faunal impoverishment of northern versus southern drainages needs to be considered. The more species rich southern fauna is a direct reflection of its greater age and geologic stability. The total for the Wapoga system compares favorably with that of the much more extensive Sepik-Ramu system of New Guinea. To date it is the most species rich system in northern Irian Jaya, but would certainly be surpassed by the much larger Mamberamo system once it has been adequately sampled.

Table 6.1. Comparison of the fish fauna of various river systems in New Guinea.

River system	Total # fish species	# Endemic fish species	Percent endemics	References
Fly, PNG	103	5	4.8	Roberts (1978)
Kikori , PNG	100	14	14.0	Allen, unpub.
Aikwa/Iwaka, Irian Jaya	80	0	---	Allen, unpub.
Lorentz, Irian Jaya	60	2	3.3	Weber (1913)
Purari , PNG	57	6	10.5	Haines (1979)
Sepik, PNG	57	0	---	Allen & Coates (1990)
Ramu, PNG	54	0	---	Allen et al. (1992)
Wapoga, Irian Jaya	46	3	6.5	this study
Mamberamo, Irian Jaya*	40	4	10.0	Allen, unpub.
Digul, Irian Jaya*	40	0	---	Allen & Boesman (1982)
Gogol, PNG	25	0	---	Parenti & Allen (1991)
Lakekamu, PNG *	23	?	?	Allen (1998)

* indicates incompletely surveyed

Species composition: altitudinal effects and upstream attenuation of species

There is a general attenuation of fish diversity as one proceeds upstream in the Wapoga system. This phenomenon is typical of other rivers in New Guinea and regions whose fauna is derived mainly from marine groups. It is also indicative of the geological youth of most of inland New Guinea. Fishes have generally had insufficient time to evolve in the interior. There are no native fishes above an elevation of about 2000 meters. This part of New Guinea has been hostile to fish evolution in recent geological times. It has been an area of tumultuous mountain building. In addition, concurrent volcanism and glaciation occurred over much of the area as recently as 300,000 years ago.

The various survey sites presented a good opportunity to study the upstream penetration capabilities of the various species. The highest number of species inhabits the lowland alluvial flood plain with rapid faunal attenuation occurring in the mountainous sections. Approximately 30 species were present near the mouth of the Wapoga River in the vicinity of the Wapoga Staging Base Camp compared to only 7 species in the torrential mountain streams near the LS-21 geological exploration camp (Stations 6-9, Appendix 12).

The observed upstream species attenuation is no doubt correlated with the disappearance of preferred habitats and increasing current velocity. Most of the lowland species are inhabitants of swamps, quiet pools, or sheltered positions along the edge of larger streams. This is particularly true of many gobioid fishes with the exception of the subfamily Sicydiinae (*Sicyopterus* and *Stiphodon*) and the Rhyacichthydae, which have well-developed pelvic suckers and are among the most successful fishes as far as ability to "climb" upstream is concerned. *Sicyopterus cyanocephalus*, one of the largest New Guinea "sucker-gobies" was the only species collected from streams at Wapoga Alpha at an altitude of approximately 1065 m, the highest point sampled for fishes during the survey. Table 6.2. shows the general trend of species attenuation as one proceeds upstream in the Wapoga system. Upstream penetration capabilities of individual species are summarized in Table 6. 3.

Table 6.2. Upstream attenuation of Wapoga fishes.

DISTANCE FROM SEA (km)	ELEVATION (m)	NUMBER OF SPECIES
10	10	28
130	80	20
200	300	7
260	1000	1

Table 6.3. Upstream Penetration of Wapoga Fishes.
The middle columns indicate the approximate maximum altitudinal and upstream distance penetration. Values are from G. Allen's personal data. Those shown with an asterisk (*) indicate data recorded during the present survey.

Species	max. altitude (m)	distance from sea (km)	habitat preference
Anguilla spp.	1,500	300	fast rocky streams
Arius velutinus	430	300	slow turbid rivers
Neosilurus novaeguineae	300	300	pools, slow-fast current
Chilatherina alleni	335*	203*	rocky streams, slow or fast
Glossolepis leggetti	80*	135*	pools, slow current
Melanotaenia praecox	70*	130*	pools, slow current
Melanotaenia rubripinnis	335*	200*	pools in forest streams
Microphis brachyurus	10 *	50	slow, muddy or rock streams
Ambassis interruptus	25	380	in vegetation, slow current
Ambassis macracanthus	70*	125*	in vegetation, slow current
Hephaestus transmontanus	470	680	rocky pools at base of rapids
Mesopristes argenteus	15	120	pools, slow current
Glossamia beauforti	290*	200*	log jam pools, slow current
Lutjanus spp.	50	120	pools, slow current.
Toxotes jacularix	10	20	surface waters, slow current
Scatophagus argus	10	20	pools, slow currents
Cestraeus goldiei	350	200*	pools at base of rapids
Liza subviridis	80*	135*	shallows, slow current
Awaous melanocephalus	80*	135*	gravel bars, slow or medium
Glossogobius bulmeri	460	680	rocky streams, relatively fast
Glossogobius circumspectus	10	20	mud bottom of slow streams
Glossogobius koragensis	25	280	mud bottom of slow streams
Periophthalmus sp.	10	20	mud bottom of tidal streams
Redigobius bikolanus	15	120	pools, slow current
Schismatogobius marmoratus	75*	132*	rocky streams, relatively fast
Sicyopterus spp.	1065*	260*	rocky streams, relatively fast
Stiphodon semoni	170	125*	rocky streams, relatively fast
Rhyacichthys aspro	290*	200*	rocky streams, fast current
Belanobranchus belanobranchus	50	20	mud/rock, slow streams
Butis spp.	15	120	in vegetation, slow current
Eleotris spp.	10	30	pools, slow-medium current
Hypseleotris sp.	45	60	in vegetation, slow current
Mogurnda nesolepis	100	790	pools in forest streams
Mogurnda sp.	70*	130*	pools, slow current
Ophieleotris aporos	430	400	in vegetation, slow current
Oxyeleotris fimbriata	1250	930	pools, slow to fast current
Prionobutis microps	10	20	mud bottom of slow streams
Tetraodon erythrotaenia	10	20	slow, turbid tidal streams

Behavioral modes and feeding relationships

Table 6. 4. shows the main activity modes of Wapoga fishes. Well over one-half of the fauna is composed of species that live on or near the bottom of rivers and streams. The most prominent in this respect are gobies and some gudgeons, which rest directly on the substratum or catfishes and grunters, which actively swim over it. The remaining fauna is composed of fishes that either actively swim or hover well above the bottom. This category includes small hovering gudgeons and more active forms such as rainbowfishes. The latter group often school in large numbers close to the surface.

Table 6.4. Activity modes and feeding modes of Wapoga fishes.

Activity Mode	Percentage (N=46 species)
Diurnal benthic	67.4
Midwater and surface	19.6
Grazing schools	4.3
Nocturnal benthic	4.3
Cryptic	4.3
Feeding Mode	
Carnivore	63.0
Omnivore	21.7
Herbivore	15.2

The main feeding types of Wapoga fishes are indicated in Table 6.4. The majority of species are carnivorous, which is typical for both tropical streams and coral reef systems. Aquatic and terrestrial insects and various aquatic larval insects feature prominently in the diet of numerous small fishes, particularly rainbows. The remaining 37 percent of the fauna consists of fishes that are either purely herbivorous or omnivorous. Of the herbivores, the mullets are particularly prominent. *Liza subviridis* often forms schools in shallow sunlit sections of the river where it grazes green filamentous algae from rocky substrates. The Sepik Grunter, *Hephaestus transmontanus*, is one of the most prominent omnivores. It consumes a variety of invertebrates including prawns and insects, but also ingests a significant amount of algae.

Zoogeographic affinities and endemism of the Wapoga fish fauna

Zoogeographic affinities of Wapoga system fishes are summarized in Table 6.5. The majority of species are either forms restricted to northern New Guinea or are relatively widespread in the Indo-Australian Archipelago (Philippines-Indonesia-PNG-Australia) or beyond into the greater Indo-Pacific area. The latter category is comprised of fishes that possess marine larval stages and generally do not penetrate very far inland.

Table 6.5. Zoogeographic affinities of Wapoga fishes

Zoogeographic Region	Number of species
New Guinea	2
N. New Guinea and Australia	2
Western Pacific	5
Indo-Australian Archipelago	11
Indo-Western Pacific	11
Northern New Guinea	14

The Wapoga drainage lies at the western extremity of the Great Northern zoogeographic province as defined by Allen (1991). This is the largest of the six major subprovinces and includes all drainages lying north of the Central Dividing Range between the Markham River system of PNG and the eastern half of Cenderawasih Bay, Irian Jaya. The overall fauna of this region is strongly endemic at the species level and contains the endemic rainbowfish genera *Chilatherina* and *Glossolepis*. Of the fishes recorded from the Wapoga system during this survey 14 species or approximately 30 percent of the fauna is composed of northern New Guinea endemics.

The results of the RAP survey indicate the strong probability that the drainages flowing into eastern Cenderawasih Bay form a localized area of endemism within the Great Northern Province. This observation is based on the occurrence of three new species collected during the survey including two rainbowfishes (*Glossolepis leggetti* and *Melanotaenia rubripinnis*) and an undescribed "sucker-goby" (*Sicyopterus*). Further collections are required to confirm the precise boundaries of this endemic sub-region.

Introduced fishes

Fresh water systems of the New Guinea-Australia region have relatively few fish species compared to their counterparts in South-east Asia, Africa, and South America. Therefore, the introduction of exotic fishes is more likely to have immediate detrimental consequences. Introduced species are likely to compete for food and living space, and in some instances they may feed on the young or adults of native species. There is absolutely no justification for the introduction of any fish species anywhere in New Guinea. Unfortunately about 15 species have already been introduced, mainly for fisheries purposes.

No introduced fish species were detected during the RAP, which is most likely a reflection of the low human population in the area. Future transmigration programs would likely result in the introduction of pest species. For example, the Timika area of southern Irian Jaya has experienced a transmigration explosion (from a few hundred original inhabitants to approximately 60,000 in 1998). Streams that were formerly inhabited by native fishes only are now home to notorious pest species including Tilapia (*Oreochromis mossambica*), Climbing Perch (*Anabas testudineus*), Walking Catfish (*Clarias batrachus*), Snakehead (*Channa striata*), and Tinheads (*Apocheilus panchax*).

CONCLUSIONS AND RECOMMENDATIONS

Fishes are an important part of the Wapoga biota. They should form an integral part of any conservation-based programs or strategies in the area for the following reasons:

- The Wapoga River system, including its many tributaries, is one of the largest aquatic habitats in northern Irian Jaya.
- Most of the Wapoga system, aside from the areas where logging has occurred, offers a pristine aquatic habitat, which has a unique assemblage of native fishes. Moreover, the area appears to be uncontaminated by introduced fishes.
- The Wapoga system is inhabited by at least three probable endemic fishes, all of which are undescribed. These include two species of rainbowfishes and a goby.

Threats to the aquatic environment at this point in time appear to be minimal, but this situation could change quickly, particularly if large-scale logging or transmigration is initiated. Transmigration is probably the biggest threat as this activity invariably results in the introduction of exotics. Once established, the effects of introduced species on the native fauna are invariably deleterious and almost always irreversible. Any future mining activity would also impact, but based on data gathered in the Timika area (Allen, unpublished data) the detrimental effects would be highly localized and temporary. The Timika experience indicates that although the tailings deposition area is heavily impacted, the numerous tributary streams form an effective refuge for native fishes.

Given the current low human population and relatively pristine state of the aquatic environment, there is probably no obvious justification for the establishment of special reserves to insure the preservation of the aquatic habitat. However, given the unique faunal assemblage, including the presence of three probable endemic fishes, there is certainly some rationale for the establishment of a wildlife reserve encompassing at least some sections of the Wapoga drainage. The presence of two new endemic rainbowfishes is particularly noteworthy. Rainbows, a family of small extremely colorful fishes that are unique to New Guinea and northern Australia, are the aquatic equivalent of the bird-of-paradise, and should be accorded equal conservation consideration and status.

CHAPTER 7

AMPHIBIANS AND REPTILES OF THE WAPOGA RIVER AREA, IRIAN JAYA, INDONESIA

Stephen Richards, Djoko T. Iskandar and
Allen Allison

Chapter Summary

- Seventy-two species of amphibians and reptiles, equivalent to roughly 22% of the known herpetofauna of Irian Jaya, were recorded from four sites at altitudes between 80-1890 m a.s.l.
- At least 29 species of frogs and two species of reptiles may be new to science.
- Several poorly known frogs were collected for the first time since they were discovered early this century, and *Rana jimiensis* Tyler was recorded from the province for the first time.
- Frog diversity was exceptionally high; this RAP survey increased the known frog fauna in Irian Jaya by nearly 30%, providing compelling evidence that frog diversity in the province is significantly higher than currently recognized.
- Populations of upland stream-dwelling frogs that are ecologically and phylogenetically related to declining species in Australia were healthy and vigorous, indicating that they have remained isolated from the agent(s) causing population declines.

Ringkasan Bab

- Tujuhpuluh dua spesies amfibia dan reptilia, sama dengan 22% herpetofauna yang diketahui di Irian Jaya, dapat dicatat dari empat lokasi pada ketinggian 80-1890 m dpl.
- Paling tidak 29 spesies katak dan dua spesies reptilia merupakan penemuan baru bagi ilmu pengetahuan.
- Beberapa jenis katak yang belum banyak diketahui berhasil dikoleksi untuk pertama kalinya sejak ditemukan awal abad ini, dan *Rana jimiensis* (Tyler) tercatat pertama kali dipropinsi ini.
- Keanekaragaman katak cukup tinggi; survai RAP ini menambah jumlah katak yang sudah diketahui sebesar 30%, memberi bukti nyata bahwa keanekaragaman katak di propinsi ini lebih tinggi dari yang dibayangkan.
- Katak kerdil penghuni hulu sungaiyang secara ekologis dan filogenetis berhubungan dengan spesies yang jumlahnya menurun di Australia, ditemukan dalam populasi yang banyak dan sehat , menunjukkan bahwa populasi tersebut terisolasi oleh agen-agen yang menyebabkan populasinya berkurang.

INTRODUCTION

To date, at least 98 species of frogs and 231 species of reptiles have been recorded from Irian Jaya. The herpetofauna is closely related to that of neighboring Papua New Guinea (PNG), where at least 510 species are known. The total land areas (Irian Jaya 416,129 km^2 vs. PNG 475,369 km^2) and topography of Irian Jaya and PNG are similar, suggesting that either the Irian Jaya fauna is depauperate, or that it is poorly documented relative to PNG. There have been few scientific surveys in Irian Jaya compared with PNG and the number of museum specimens from Papua New Guinea outnumber those from Irian Jaya by a factor of at least 15:1 (Allison and Dwiyahreni 1997), suggesting that the latter explanation is more likely to be true.

Survey effort for frogs and reptiles in Irian Jaya has not been uniform across the province. Early collections were restricted to coastal lowlands and offshore islands. The first frog described from New Guinea, *Rana papua* Lesson 1830, was collected from Waigeo Island in the Rajah Ampat archipelago, and other important collections were subsequently made on Aru, Yapen, Biak, and the Raja Ampat islands off western and northern Irian Jaya (e.g. Meyer

1874). It was not until the explorations of Luigi D'Albertis, O. Beccari and A.A. Bruijn in the early 1870s that the first collections of herpetofauna in the mountainous interior of mainland Irian Jaya were made. D'Albertis and his fellow naturalist-explorers accumulated significant collections of frogs and reptiles, particularly from the Arfak Mountains of the Vogelkop Peninsula, and these were summarized in a major monograph by Peters and Doria (1878).

The frogs and reptiles of the central mountain ranges east of the Vogelkop remained largely unstudied until a series of expeditions to the catchments of the Lorentz, Digul and Idenburg Rivers in the first half of the twentieth century. Notable for their important collections of frogs and reptiles were the H.A. Lorentz (1907-1913), British Ornithologists Union (1909-1910), and Wollaston (1912-1913) expeditions to the southern slopes of the Snow Mountains, and the Third Archbold Expedition (1938-1939) to the north slopes of the Snow Mountains. More recently a major biodiversity survey of the PT Freeport contract-of-work area on the southern slopes of the Snow Mountains has added substantially to our knowledge of the herpetofauna of this region (Allison and Dwiyahreni 1997).

A number of other expeditions made collections of frogs and reptiles in the mountainous regions of mainland Irian Jaya but at best most areas are inadequately surveyed; the herpetofauna of many mountain ranges remains completely unknown.

Brief overview of frog fauna

Anurans (frogs and toads) are the only amphibians found in Irian Jaya. Four native frog families are represented: The Hylidae (39 species in 2 genera) and Myobatrachidae (5 species in 3 genera) are of Gondwanan origin and are the dominant groups in Australia. The Ranidae (13 species in 3 genera) and Microhylidae (39 species in 12 genera) are of southeast Asian origin. The Microhylidae has undergone an extensive radiation within New Guinea and is included in two endemic sub-families; the Asterophryinae endemic to New Guinea and the Moluccas, and the Genyophryninae distributed between the southern Philippines and northern Australia but reaching its greatest diversity in New Guinea. Both subfamilies of microhylids, and the ranid genus *Platymantis*, have unusual reproductive strategies involving the direct development of embryos into froglets within the egg capsule.

An additional family, the Bufonidae, is represented in Irian Jaya by *Bufo melanostictus*, which is a recent introduction to the province and currently known only from the Manokwari area (D. Iskandar, pers. obs). A second introduced toad, *Bufo marinus*, is widespread in lowland eastern and northern Papua New Guinea (PNG), and will probably cross the border into Irian Jaya within the next few years.

These four native frog families also represent all PNG frogs. Despite the close relationship between the faunas of these two political "regions" there are some significant differences in their composition. The Irian Jaya frog fauna shows a much lower level of endemism at the species level (30%) than the PNG frog fauna (63%). Furthermore there are no frog genera endemic to Irian Jaya, but four microhylid genera (*Aphantophryne*, *Barygenys*, *Genyophryne* and *Pherohapsis*) are found only in Papua New Guinea. Although these patterns of endemism may in part reflect differences, in geological history of eastern and western New Guinea (e.g. Polhemus and Polhemus 1998), it is more likely that additional surveys in Irian Jaya will reveal many new and endemic taxa.

There are a number of New Guinea genera that, although not endemic to Irian Jaya, reach their greatest diversity in the province. These include the closely related fossorial microhylid genera *Xenobatrachus* and *Xenorhina* with 18 species (11 endemic). Recent field work revealed two undescribed species of *Xenobatrachus* and an undescribed *Xenorhina* in a single mid-montane valley (the Eipomek Valley; Blum and Menzies 1988), suggesting that many more endemic species in these genera await discovery in the mountainous regions of Irian Jaya.

Six species of the predominantly scansorial and arboreal genus *Oreophryne* are currently recognized from Irian Jaya (compared to nine in PNG), but the genus is far more diverse in western PNG and Irian Jaya than currently recognized. *Oreophryne* species largely replace the morphologically and ecologically "equivalent" *Cophixalus* in western New Guinea. *Cophixalus* is represented by 15 species in PNG but only one species (*C. biroi*) extends into Irian Jaya. Additional field surveys and taxonomic studies in Irian Jaya are likely to demonstrate that *Oreophryne* is the most diverse microhylid genus in the province.

More field surveys and taxonomic research are urgently required before a full understanding of the distribution, diversity and patterns of endemism of the frog fauna of Irian Jaya can be assessed. In particular, the conservation status of native frogs should be assessed. Amphibian populations have been declining globally, and a number of factors that have caused declines elsewhere (Alford and Richards 1999) may be operating in Irian Jaya. Of particular concern is the introduction of at least three exotic frog and toad species to the province: *Bufo marinus*, *B. melanostictus*, *Limnonectes cancrivorus* (D. Iskandar, pers. obs; Menzies 1996). The impacts of these species on native frogs should be assessed as a matter of urgency.

An overview of distribution patterns, conservation status, and research priorities for Irian Jayan frogs is being prepared by S. Richards and will be published elsewhere.

METHODS

The rapid assessment of herpetofauna was conducted from 3 to 19 April 1998 (see Appendix 1). Two of us (S. Richards and D. Iskandar) collected voucher specimens of frogs and reptiles at Siewa Base Camp (80 m; 2 days), Wapoga Alpha Camp (1070 m; 9 days), and Helipad 55 (1890 m; 5 days). Additional material was collected by M. Moore and A. Mack at Logari/Landing Site 21 (LS21; 275 m) during their fieldwork there (Appendix 1), and several interesting specimens were collected by other members of the RAP team.

At each site we identified all accessible habitats and conducted intensive searches for frogs and reptiles. During the day we searched for heliothermic (basking) reptiles along forest trails, clearings, and stream banks. Small lizards were collected after being stunned with a large rubber band. Large lizards and snakes were collected by hand. S. Richards snorkelled for turtles at Siewa. Non-heliothermic reptiles were sampled by searching in deeply shaded forest, during rain, or at dusk. We searched for nocturnal reptiles, including geckos, by walking along forest trails and stream banks at night with headlamps.

We searched for frogs at night by conducting visual-encounter and aural surveys along rivers and streams, and in and around ponds and swamps. Because a large proportion of Irian frogs have life cycles that are independent of free-standing water, we also conducted extensive visual and aural searches along forest trails away from water. During the day we searched for diurnal frogs along streams, and sampled tadpoles with a dip-net in all available water bodies.

Whenever possible we recorded the advertisement calls of frogs with a Sony Pro-Walkman Tape Recorder and Sony ECM-Z200 microphone. Each species was photographed alive before preparation as voucher specimens. We euthanized all specimens by submersion in chlorotone (for amphibians and small reptiles), or with lethal injection for large reptiles. We prepared specimens for collections and morphological work by either fixing in 10% formalin solution, and then storing in 70% ethanol, or by both fixing and storing in 70% ethanol.

Voucher specimens will be deposited in the Museum Zoologicum Bogoriense, Bogor, Indonesia and the Queensland Museum, Australia.

RESULTS

Seventy-two species of amphibians and reptiles were recorded during the RAP survey (Appendix 13). Forty-six species of frogs and twenty-three species of reptiles were collected as specimens; one frog and two reptile species were positively identified but not collected. Most effort was devoted to and the most interesting finds were among the frog fauna. Reptile sampling was less complete thus the bulk of this report is devoted to frogs. More sampling, particularly of frogs is needed before any comprehensive statements on the herpetofauna of the region can be attempted.

General natural history observations of frogs are incorporated into species accounts (Appendix 14). Twenty nine species of frogs did not reliably match any of the currently recognized species, and very likely represent new taxa. Likewise two species of reptiles may represent new taxa. The microhylid genus *Oreophryne* is in a state of taxonomic chaos but all ten species collected during the RAP are likely to represent undescribed taxa. At least one scincid lizard in the genus *Emoia* is an undescribed species, and a large gecko in the genus *Cyrtodactylus* appears to be new to science.

Our collections document significant range extensions for at least four frog species. These include three frogs known previously from single collections early this century, and one frog previously known only from Papua New Guinea. The frog fauna of the Wapoga River headwaters region is exceptionally diverse, reflecting the altitudinal range and diversity of habitats accessed during the survey. The two most diverse groups were torrent-dwelling treefrogs of the genus *Litoria*, which reached their greatest diversity at Wapoga Alpha Camp (1070 m), and frogs of the microhylid genus *Oreophryne* which were abundant at both montane sites.

Torrent-dwelling *Litoria* have a reproductive strategy involving the deposition of large, unpigmented eggs beneath stones in torrential streams, and have tadpoles with reduced fins, a dorso-ventrally flattened body, and a large ventral suctorial mouth to provide adhesion to rocks in swiftly flowing water (e.g. Haas and Richards 1998). We collected samples of several tadpoles belonging to this group, but were unable to associate them with adult frogs. Analyses of DNA samples from tadpoles and frogs may permit positive identification of these samples at a later date. There is an extensive evolutionary radiation of torrent-dwelling *Litoria* throughout the mountains of New Guinea, and the large number of undescribed taxa recorded during this RAP indicates that many more species remain to be discovered in remote mountainous regions of Irian Jaya.

Frogs of this group are ecologically and taxonomically (in the same genus) related to species that have undergone catastrophic population declines in northern Queensland, Australia. At each of the upland sites torrent-dwelling frogs were abundant and appeared in good health. The presence of large numbers of suctorial tadpoles in the streams indicated that most if not all species in this group were

breeding successfully. Our observations indicate that these populations have remained isolated from the agent(s) of amphibian population declines. The Wapoga Camp would provide an ideal base for long-term studies of the health of frog populations in this region.

The taxonomy of *Oreophryne* is chaotic. The genus occurs from the southern Philippines to eastern Papua New Guinea, but reaches its greatest diversity on mainland New Guinea where 11 species are recognized (Zweifel 1985). Like other Australopapuan microhylid frogs, *Oreophryne* species have a reproductive strategy that does not include a free-swimming aquatic tadpole. Embryonic development occurs entirely within the egg capsule, from which a fully formed adult hatches. The evolutionary shift away from dependence on free-standing water appears to have facilitated an extensive radiation of *Oreophryne* in the often steep and permanently moist rainforests of montane western New Guinea.

Frogs of the genus *Oreophryne* are far more ecologically and morphologically diverse than has previously been recognized. Habits range from semi-fossorial to terrestrial, scansorial, arboreal and possibly semi-aquatic (S. Richards, pers. obs.). S. Richards has collected more than 15 undescribed *Oreophryne* in the mountains of western Papua New Guinea, and another 10 undescribed species were recorded during this survey. These included a large species found high in *Pandanus* trees, and a tiny species that may be Irian Jaya's smallest known vertebrate. Two other microhylids that were almost certainly *Oreophryne* species were calling from > 30m in the forest canopy at Siewa, but are excluded from consideration in this report because no specimens were obtained. It is clear that the genus *Oreophryne* is far more diverse in Irian Jaya than is currently recognized.

The reptile fauna was under-represented in our collection, largely because survey effort was concentrated at extremely wet montane sites where reptile diversity is relatively low. Despite this, one large gecko of the genus *Cyrtodactylus*, and a skink of the genus *Emoia*, probably represent undescribed taxa. Additional sampling in lowland and foothill forest will increase the reptile fauna known from this area substantially.

CONCLUSIONS AND RECOMMENDATIONS

The amphibian and reptile fauna of the Wapoga River Area is extemely rich, indicating that the overall fauna of Irian Jaya is much greater than has been documented. The results of this RAP survey provide compelling evidence that the frog fauna of Irian Jaya is very poorly known. Additional surveys in remote regions will undoubtedly increase the fauna significantly, and the likelihood of discovering unusual and spectacular undescribed taxa is very high.

Additional biological surveys are urgently needed to determine the ranges of the poorly known and previously undescribed species, to identify and protect hotspots of endemism, and to document and prevent the spread of exotic species (e.g. *Bufo marinus*). Long term monitoring should be implemented for populations of several frog species that are ecologically and phylogenetically related to declining species in Australia to provide insight into causes and possible prevention of further declines.

CHAPTER 8

BIRDS OF THE WAPOGA AREA, IRIAN JAYA, INDONESIA

Andrew L. Mack, Wahyu Widodo, and Boeadi

Chapter summary

- 213 species of birds were positively identified; of these, two thirds (143 species) are confined to the island of New Guinea.
- Five bird species recorded are listed as "vulnerable," two species are listed as "data deficient," and four species are listed as "near threatened."
- The area around Siewa Camp had recently been logged, but bird populations here seemed fairly intact.
- The region has several bird species with restricted ranges in the north coast, suggesting a subregion with some endemism.
- Conservation actions in Irian Jaya should include this subregion, as endemism among highly vagile birds suggests even greater endemism in less mobile taxa.

Ringkasan Bab

- 213 spesies burung berhasil diidentifikasi; diantaranyadua pertiga (143 spesies) hanya terdapat di pulau Irian.
- Lima spesies burung tercatat sebagai "rawan," dua spesies tercatat sebagai "tidak cukup data," dan empat spesies tercatat sebagai "hampir terancam."
- Baru-baru ini kawasan disekitar Camp Siewa ditebangi, tetapi populasi burungnya tampak belum terganggu.
- Kawasan ini memiliki beberapa spesies burung dengan penyebaran yang terbatas di pesisir utara, mengindikasi adanya suatu subregion dengan tingkat endemisitas tertentu.
- Kegiatan konservasi di Irian Jaya harus memasukkan subregion ini, karena endemisitas dari burung-burung yang jelajahnya luas menunjukkan endemisitas yang lebih tinggi dibandingkan taksa yang lebih sempit jelajahnya.

INTRODUCTION

Few ornithological explorations have been undertaken in the region where the western end of the main central cordillera of Irian Jaya comes to a terminus south of Geelvink Bay and east of the "Bird's Neck" region, particularly on the north side of the mountains. The Weyland Mountains have been explored by Stein (Stresemann et al. 1936) and others (Rothschild 1921, 1931). The Paniai Lakes area in the highlands has been visited by ornithologists (e.g. Junge 1953), and the Snow Mountains have received considerable attention, particularly on the southern flank, further east of the RAP survey (e.g., Oglivie-Grant 1915; Junge 1937, 1939; Rand 1942). To the south, recent work has occurred in the contract area of the Freeport Mining Company (van Balen and Rombang 1998). The north side of the central ranges down to the lowlands has been essentially unvisited by ornithologists, as have the Minimtara Mountains. Dr. Jared Diamond has recently visited the Van Rees Mountains. The region visited by the 1998 Irian RAP survey team was identified as an area in particular need of basic inventory by the 1997 Irian Jaya Biodiversity Conservation Priority-Setting Workshop in Biak (Supriatna et al. *in press*).

METHODS

As part of the April 1998 Conservation International RAP expedition, we surveyed birds at four camps identified in the introduction of this report: Siewa Base Camp (80 m), Logari (LS-21) Camp (275 m), Wapoga Alpha Camp (1070 m), and Helipad 55 (1890 m; see Appendix 1). The camps spanned lowland rainforest to montane forest. See the Introduction Chapter for more details regarding these sites. At the last three camps birds were sought along existing trails, along new transects through forest, and at the helipad clearings at

each site. Total transect lenghts were about 2 km at HP55, 7 km at Wapoga Alpha Camp, and 4 km at LS-21. At Siewa Base Camp most observations were made along 10 km of abandoned logging roads and skidder tracks in the area or along the Wapoga River. Approximate numbers of each species encountered were recorded and incorporated into a relative scale as rare, uncommon, or abundant (see Appendix 15). At all four camps bird vocalizations were recorded using a Sony TCM 5000 recorder and Sennheiser ME66 microphone. These recordings are deposited at the Cornell Laboratory of Ornithology Library of Natural Sounds. At Helipad 55 and Wapoga camps a few mist nets were run *ad arbitrium*. Voucher specimens of netted taxa were prepared in the field and are all deposited in the collections of the Museum Zoologicum Bogoriense, Bogor, Indonesia.

RESULTS AND DISCUSSION

During 27 days of field work, 213 species of birds were positively identified (Appendix 15). Of these, two thirds (143 species) are endemic to the island of New Guinea. Of the 70 species observed that occur outside of New Guinea, 38 are known from other parts of Indonesia, thus roughly 175 (82%) of the species recorded are not expected to be found elsewhere in Indonesia outside of Irian Jaya. Six species were possibly migrants from outside Irian Jaya, all others could safely be considered resident species. Fifty-seven species that had not been recorded on the recent Biodiversity survey of the PT Freeport holdings to the south were recorded during this RAP survey.

IUCN (1996) and BirdLife International (Collar et al. 1994) list five bird species recorded on the RAP as "vulnerable:" *Casuarius unappendiculatus*, *Goura victoria*, *Psittaculirostris salvadorii*, and *Psittrichas fulgidus*, and *Archboldia papuensis*. Two species are listed as "data deficient:" *Androphobus viridis*, and *Philemon brassi*. Four species are listed as "near threatened:" *Casuarius bennetti*, *Zonerodius heliosylus*, *Aquila gurneyi*, and *Probosciger aterrimus*.

As would be expected, species richness declined with increasing altitude (Table 8.1.). The species count at Wapoga was greater than expected given the elevation because more time was spent here than at the other camps. Had we left after six days of field work at Wapoga, the species count would have been about 72. At all camps, sampling was incomplete; more time would have been required to obtain a species list that approached complete. It is our hope, however, that these data will serve as stimuli for more biological survey work in the area. Because the ongoing geological exploration in the area could enable biologists to access the area, more thorough sampling is a distinct possibility.

Table 8.1. Synopsis of avian survey effort and results at four camps in northern Irian Jaya.

camp	elevation (m a.s.l.)	# bird species recorded	# field days
Siewa Base Camp	80	102	6
Logari (LS-21)	275	79	6
Wapoga Alpha	1070	85	9
Helipad 55	1890	64	6

General impressions of the avifaunas at the four camps

Siewa camp (80 m)

Despite the heavy and recent disturbance around Siewa Camp, there are still many birds in the area that are often considered vulnerable to disturbance. Northern Cassowaries were seen several times by members of the RAP team, Goura pigeons were noted several times, hornbills and Palm Cockatoos were abundant. Logging activities in the area had terminated just five months prior to the survey (October 1997). The abundance of cassowaries, Goura pigeons and hornbills suggests that the loggers did not hunt extensively with guns, a common source of collateral impact in some logging operations elsewhere in the world.

Although skidder tracks ramified through the forest, there were still some areas where the canopy was relatively intact, not too different from lowland forest that has experienced unusually high natural disturbance in the form of windthrows. However, the region disturbed by logging was much broader in scale than what normally occurs due to natural disturbance. The aggressive invasive vine *Ipomea* thickly shrouded the sunny forest edge along the logging roads where other second growth woody species like *Macaranga* were also abundantly established. Because of the abundant second growth, numerous bird species (e.g. *Aviceda subcristata*, *Falco berigora*, *Centropus menbeki*, *Merops ornatus*) that are typical of disturbed regions were also present at Siewa. Thus the area has relatively high bird species richness due to the mix of primary and secondary forest species plus additional species typical of large rivers and gravel beds (e.g. *Tadorna radjah*, *Charadrius dubius*).

Our visit was inadequate to determine the effect of the logging on bird species normally confined to undisturbed forest interiors (e.g., *Pitta* spp.) because little effort was made to penetrate far from roads or skidder tracks. From the air it appeared that there were some areas that were uncut within 10 km of Siewa. We very tentatively predict that the forests around Siewa could recover to a near-full complement of the original avifauna if no more logging occurs in the next twenty years and if settlers do not enter the area via the logging roads.

Logari camp (275 m)
This camp was in the first hills abutting the lowland alluvial plain to the north. The avifauna was essentially that of lowland forest but lacked the "pure" lowland species *Goura cristata* or those found along larger rivers like *Tadorna radjah*. At the Logari camp the river was rocky and faster moving than at Siewa Camp. Logari had such hill forest bird species as *Sericornis spilodera*, *Cicinnurus magnificus* and *Chaetorhynchus papuensis*. However, the avifauna was more strongly comprised of lowland species (see Appendix 15). As at Wapoga there was little in fruit and frugivorous birds (e.g. *Ptilinopus* spp. were absent or inconspicuous) whereas at Siewa, where more trees were in fruit, *Ptilinopus* spp. and other frugivores were conspicuous. In New Guinea it is believed that many frugivores are semi-nomadic, tracking fruit availability over large areas, thus it is difficult to make definitive conclusions of the presence or absence of frugivores (likewise nectarivores) based on short surveys.

Wapoga camp (1070 m)
As at the Helipad 55 there was a marked absence of fruiting trees, depressing the numbers and diversity of frugivorous birds found. However, there were several common tree species that were in flower and greater numbers of nectarivores (e.g., *Myzomela* spp.) were observed at this camp. The forest at this camp was quite different. A species of *Agathis* (Araucariaceae) was a conspicuous dominant emergent. Epiphytic growth was not so dense as might be expected at this elevation, suggesting the area is relatively dry. On the basis of the local topography, the site could lie within a rain shadow. The area would be expected to have nutrient-poor soils due to the kind of parent rock substrate (Freeport geologists, personal communication). Apparently the area has had no recent human inhabitants—there is no evidence of gardens visible from the air and during the long period Freeport geologists worked here, no local people visited their camp. Such truly uninhabited areas are unusual in New Guinea and usually occur where soils are too poor to sustain gardens.

The site seemed to straddle a transition zone and notable differences in the flora and avifauna could be observed from the lower part of the survey area to the higher part, a difference of only 200 m elevation. Some bird species usually expected at somewhat higher elevations were found at the upper end (1200 m) of the area surveyed (e.g., *Crateroscelis nigrorufa*, *Lophorina superba*). Bird species that seemed confined to the lower part of the area included *Probosciger aterrimus*, *Pachycephala hyperythra* and river edge species like *Motacilla cinerea*. Two species that normally are elevational replacements were completely sympatric at this site (*Toxorhamphus poliopterus* and *T. novaeguineae* were netted together).

Generally, many bird species were not as abundant or conspicuous at this site as normally expected, perhaps indirectly as a consequence of low nutrient soils. A number of normally conspicuous species that would be expected were never recorded (e.g. *Cracticus cassicus*, *Xanthotis flaviventer*, *Mino dumontii*, *Dicaeum pectorale*, several psittacids and columbids, etc.).

Helipad 55 (1890 m)
The dense fog during our visit and the thick shroud of epiphytic growth on every surface indicated this was everwet cloud forest. Many of the birds observed here (e.g., *Ifrita kowaldi*, *Eulacestoma nigripectus*) were typical of cloud forest of the Central Ranges. A few species (e.g. *Androphobus viridis*) indicated the site is biologically allied to the Snow Mountains. Had there been more time to survey the area, particularly to reach higher elevations, we undoubtedly would have encountered more species. A trail that went above the camp about 120 m in elevation ended in stunted and gnarled forest that was extremely difficult to move through and there was inadequate time or manpower to cut a trail higher.

Beyond the helipad clearing, there was little evidence of human disturbance at this site. There were numerous clearings and gardens in the valley far below the camp, and daily visitors from the valley indicated the area is probably hunted regularly. Our inability to communicate with the local people precluded any effort to interview hunters. However hunters would probably impact the mammalian fauna more than birds, as there are relatively few large birds at this elevation. Few cassowary signs were observed, but this could well be the norm and not indicative of hunting. There were few trees fruiting at the time, so an absence of cassowary sign is not unexpected. The scarcity of fruiting trees probably contributed to the difficulty of finding frugivorous birds in general. Likewise, the scarcity of trees in flower probably caused nectarivorous birds (e.g., *Myzomela* spp.) to be more poorly represented than would be expected at this elevation.

Noteworthy species observed

The avifauna of Irian Jaya has a number of endemic species, approximately 65 (depending on taxonomy used), that do not occur in eastern New Guinea (Papua New Guinea). However many of these, 28 species, are confined to the Aru, West Papuan and Geelvink Bay islands. Approximately 32 species are endemic residents to mainland Irian Jaya. The majority of these are confined to either the Vogelkop area or high elevations of the Snow Mountains. Four noteworthy species that are Irian endemics (3) or very restricted in distribution (1) were observed during the RAP survey (see Appendix 16 for more information).

CONSERVATION RECOMMENDATIONS AND CONCLUDING REMARKS

The presence of a few bird species with ranges restricted to the north lowlands and foothills of Irian Jaya corroborates the findings by other RAP team members that this area might be sufficiently distinct to warrant greater conservation attention. Without further survey work in the area, it is still premature to conclude whether existing protected areas in Irian Jaya are adequate to conserve the avian diversity in this region. Additional surveys of the avifauna of this region of Irian Jaya are needed.

CHAPTER 9

MAMMALS OF THE WAPOGA RIVER AREA, IRIAN JAYA, INDONESIA

Boeadi and Wahyu Widodo

Chapter summary

- Sixty-two mammals, including 7 species of bats, and 2 species of rodents were trapped during the survey. Two more species (one marsupial and one rodent) were seen but not collected.

Ringkasan Bab

- Enampuluh dua mamalia, termasuk 7 spesies kelelawar, dan 2 spesies rodentia berhasil di tangkap selama survai ini. Dua spesies lainnya (satu marsupial dan satu rodentia) dapat teramati tapi tidak di koleksi.

INTRODUCTION

The mammal fauna of Irian Jaya is poorly known with only 164 species documented from the region compared to 227 for Papua New Guinea. Mammal surveys have been conducted directly to the south of the RAP survey area in the Contract of Work Area A (COW A) of the P. T. Freeport Indonesia company (Kitchener et al. 1998). Other than that, little other mammalian survey work has occurred in the western end of the central highlands in Irian Jaya. The 1938-1939 Archbold Expedition visited the Snow Mountains, Flannery visited the Lorentz area several times, sometimes accompanied by the first author of this short chapter. Most results from these studies are not readily available in the primary literature, thus the area remains very poorly-known.

METHODS

Small rodents were trapped with live and snap traps set liberally around each camp in locations thought likely to be successful; in tangles, near the mouths of rodent dens, on game trails, etc. Bats were netted by placing mist nets around each camp site and leaving them open all night long. All specimens captured were prepared as study specimens and have been deposited in the natural history collections of LIPI (Bogor, Indonesia).

RESULTS AND DISCUSSION

Sixty-two mammals were trapped during the survey representing nine species. Two more species were seen but not trapped. Seven species of bats, three species of rodents, and one species of marsupial were encountered during the RAP survey (Appendix 17).

All of the species collected were also recorded during the more extensive work to the south in COW A. However, the survey efforts during the RAP were too limited by time, manpower and the lack of hunters to begin to approach a comprehensive inventory. Thus although no new records for the general region were made, we feel it is quite likely that more intensive survey work could reveal novel records. The species recorded and the numbers of each are recorded in Appendix 17.

GAZETTEER

See Introduction section for more complete descriptions of each survey site.

Lower Wapoga River at the Wapoga Staging Area.
2° 43.40' S, 136° 26.00' E. Elevation: 10 m a.s.l.
Aquatic samples were taken from the main river itself, and from a variety of tributaries draining both alluvial and limestone catchments. No terrestrial work was undertaken at this site.

Siewa Base Camp.
3° 02.202' S, 136° 22.515' E. Elevation 80: m a.s.l.
The Siewa Base Camp is just downstream of the Tirawiwa river's exit point from the mountains at 65 m elevation. The area was selectively logged in previous years, with operations having ceased in October 1997. The forest was laced with abandoned logging roads and skidder tracks. The primary logging roads were flanked by heavy disturbance, away from the main tracks the forest was somewhat less disturbed.

Logari/ Landing Site 21 (LS-21).
3° 00.348' S, 136° 33.412' E. Elevation: 275 m a.s.l.
The Logari River occupies a compact tributary catchment to the Ziwa River, lying north of the first range of mountain foothills. The site had lowland primary alluvial forest in basins adjoining the main river that changed into a drier, better-drained lower hill forest on the adjacent slopes.

Wapoga Alpha Camp.
3° 08.687' S, 136° 34.423' E. Elevation: 1070 m a.s.l.
The survey area spanned the transition from hill forest to lower montane forest. The headwater reach of the Ziwa River flows by the Wapoga Alpha drilling camp.

Helipad 55.
3° 26.527' S, 136° 28.365' E. Elevation: 1890 m a.s.l.
The site was on the flank of a steep mountain in primary montane forest. Due to the attenuation of aquatic diversity at high elevations in New Guinea, the aquatic scientists did not visit this site.

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APPENDICES

Participant timeline at sites surveyed during the RAP survey of the Wapoga area, Irian Jaya, Indonesia.

APPENDIX 1

SITE CODES:

S: Siewa Base Camp
HP 55: Helipad 55
WA: Wapoga Alpha Camp
LS21: Logari/Landing Site 21
WS: Lower Wapoga River at the Wapoga Staging Area.

See Gazetteer for site descriptions.

PARTICIPANTS	MARCH 1998					APRIL 1998												
	20	21	22	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mack (Birds)	S	S	S	S	S	HP55	HP55	HP55	HP55	HP55	HP55	HP55	HP55	WA	WA	WA	WA	WA	WA
Moore (Birds)							S	S	HP55	HP55	HP55	HP55	HP55	WA	WA	WA	WA	WA	WA
Richards (Herps)							S	S	HP55	HP55	HP55	HP55	HP55	WA	WA	WA	WA	WA	WA
Boeadi (Mammals)							S	S	HP55	HP55	HP55	HP55	HP55	WA	WA	WA	WA	WA	WA
Widodo (Mammals, Birds)							S	S	HP55	HP55	HP55	HP55	HP55	WA	WA	WA	WA	WA	WA
Iskandar (Herps)							S	S	HP55	HP55	HP55	HP55	HP55	WA	WA	WA	WA	WA	WA
Allen (Fishes)							S	S	S	S	LS21	LS21	LS21	S	S		S		WS
Polhemus (Insects)							S	S	S	S	LS21	LS21	LS21	S	S		S		WS
Snelling (Ants)							S	S	S	S	S	S	S	S	S	S	S	S	S
Ridsdale (Plants)							S	S	HP55	HP55	HP55	HP55	HP55	WA	WA	WA	WA	WA	WA
Mogea (Plants)									HP55	HP55	HP55	HP55	HP55	WA	WA	WA	WA	WA	WA

PARTICIPANTS	APRIL 1998																MAY 1998	
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2
Mack	WA	WA	WA	WA	WA	S	S	L	L	L	L	L	L	S	S			
Moore	WA	WA	WA	WA	WA	S	S	L	L	L	L	L	L	S	S			
Richards	WA	WA	WA	S	S													
Boeadi	WA	WA	WA	S	S	S	S											
Widodo	WA	WA	WA	S	S													
Iskandar	WA	WA	WA	S	S													
Allen	WS		S	WA	WA	S	S											
Polhemus	WS		S	WA	WA	S	S											
Snelling	S	S	S	WA	WA	WA	WA	WA	WA	WA	WA	WA	WA	WA	WA	WA	WA	S
Ridsdale	WA	WA	WA	S	S	S	S											
Mogea	WA	WA	WA	S	S													

APPENDIX 2 Botanical specimens collected by Colin E. Ridsdale on the RAP survey in the Wapoga area, Irian Jaya, Indonesia

Colin E. Ridsdale

Specimens have been deposited at the Rijksherbarium in Leiden, Netherlands.

See Introduction and Gazetteer for site descriptions.

		SITES				
FAMILY	**SPECIES**	**WAPOGA (1070m)**	**HP 55 (1890m)**	**SIEWA (80m)**	**CER COLLECTION NUMBER**	**LIFE-FORM**
Actinidiaceae	*Saurauia* sp.		X		2507	Understory shrub.
Actinidiaceae	*Saurauia* sp.		X		2494	Fallen branch fragment.
Anacardiaceae	*Campnosperma montanum*	X			2554	Tree 8 m, dbh 10 cm.
Annonaceae	*Friesodielsia* sp.	X			2564	Climber to 5 m.
Annonaceae	*Goniothalamus* sp.	X			2537	Tree 8 m, dbh 10 cm.
Annonaceae	*Pseuduvaria* sp.			X	2658	Understory tree 3 m.
Apocynaceae	*Alstonia macrophylla*	X			2547	Slender tree 15 m, dbh 12 cm.
Apocynaceae	*Melodinus* sp.	X			2531	Liane to 5 m.
Apocynaceae	*Melodinus* sp.	X			2565	Climber to 5 m.
Apocynaceae	*Melodinus* sp.	X			2629	Liane to 15 m.
Apocynaceae	*Neubergia* sp.	X			2622	Understory tree 4 m.
Aquifoliaceae	*Sphenostemon* sp.		X		2503	Tree 15 m, dbh 12 cm.
Aquifoliaceae	*Sphenostemon* sp.		X		2508	Tree 7m.
Araliaceae	*Polyscias* sp.	X			2558	Tree 8 m.
Araliaceae	*Schefflera* sp.		X		2486	Epiphyte.
Araucariaceae	*Agathis* sp.	X			2630	Tree to 25 m, dbh 1.52 m.
Asclepiadaceae	genus indet.	X			2540	Siewa Camp liane.
Asclepiadaceae	genus indet.	X			2543	Siewa Camp liane.
Asclepiadaceae	genus indet.	X			2556	Ground trailer.
Asclepiadaceae	genus indet.	X			2621	Siewa Camp liane.
Asteraceae	*Vernonia arborea*	X			2580	Understory tree 8m, bh 10cm
Begoniaceae	*Begonia* sp.			X	2481	Herb.
Begoniaceae	*Begonia* sp.		X		2487	Herb.
Chloranthaceae	*Ascarina philippenensis*	X			2628	Tree 15 m, dbh 15 cm.
Clusiaceae	*Calophyllum* sp.	X			2606	Tree 18 m, dbh 25 cm.
Clusiaceae	*Garcinia* sp.	X			2524	Tree 15 m, dbh 10cm.
Clusiaceae	*Garcinia* sp.	X			2536	Tree 25 m, dbh 40--60 cm.
Clusiaceae	*Garcinia* sp.	X		X	2563	2563A
Cucurbitaceae	genus indet.	X			2559	Tendril climber to 3 m.
Cunoniaceae	*Acsmithia* sp.	X			2605	Small tree 5 m.
Cunoniaceae	*Aistopetalum viticoides*	X			2520	Tree 20 m, dbh 30 cm.
Cunoniaceae	*Aistopetalum viticoides*	X			2573	Understory tree 12 m., dbh 14 cm.

		SITES				
FAMILY	**SPECIES**	**WAPOGA (1070m)**	**HP 55 (1890m)**	**SIEWA (80m)**	**CER COLLECTION NUMBER**	**LIFE-FORM**
Cupressaceae	*Libocedrus papuana*	X			2575	Understory conifer 4 m.
Dipterocarpaceae	*Vatica rassak*			X	2657	Tree 18 m, dbh 20cm.
Ebenaceae	*Diospyros* sp.	X			2595	Shrub 2 m.
Elaeocarpaceae	*Dubouzetia* sp.		X		2519	Tree 18 m, dbh 25 cm.
Elaeocarpaceae	*Elaeocarpus* sp.		X		2498	Tree 20 m, dbh 30 cm.
Elaeocarpaceae	*Elaeocarpus* sp.		X		2518	Tree 15 m, dbh 12 cm.
Elaeocarpaceae	*Elaeocarpus* sp.	X			2612	Tree 15 m, dbh 20 cm.
Elaeocarpus	*Elaeocarpus* sp.	X			2548	Tree 18 m, dbh 25 cm, prop roots.
Elaeocarpaceae	*Sloanea* sp.	X			2616	Small tree, 6m.
Elaeocarpus	genus indet.	X			2534	Slender tree to 12 m, dbh 10 cm.
Ericaceae	*Dimorphanthera* sp.	X			2571	Climber to 8 m.
Ericaceae	*Gaultheria* sp.		X		2501	Common epiphytic shrub.
Ericaceae	*Rhododendron* sp.	X			2641	Epiphyte.
Ericaceae	*Vaccinium* sp.	X			2521	Epiphytic shrub.
Ericaceae	*Vaccinium* sp.	X			2608	Hemi-epiphytic climber at 15 m.
Ericaceae	*Vaccinium* sp.	X			2609	Common epiphyte at 20 m.
Euphorbiaceae	*Antidesma* sp.	X			2532	Tree 8 m, dbh 12 cm.
Euphorbiaceae	*Antidesma* sp.	X			2636	Small tree 5 m, dbh 6 cm.
Euphorbiaceae	*Glochidion* sp.	X			2541	Understory regrowth tree 4 m.
Euphorbiaceae	*Glochidion* sp.	X			2619	Understory shrub 1.5 m.
Euphorbiaceae	*Homalanthus* sp.	X			2593	Subcanopy tree 10m, dbh 8 cm.
Euphorbiaceae	*Macaranga* sp.		X		2509	Primary forest tree 18 m,. dbh 20 cm
Euphorbiaceae	*Macaranga* sp.		X		2510	Primary forest tree 20 m., dbh 25 cm
Euphorbiaceae	*Macaranga inermis*		X		2511	Primary forest broad crowned tree
Fagaceae	*Lithocarpus* sp.	X			2599	Tree 12 m, dbh 12 cm.
Fagaceae	*Lithocarpus* sp.	X			2610	Tree 15m tall (fallen Branch)
Flacourtiaceae	*Casearia* sp.		X		2490	Small tree 18 m, dbh 25cm.
Flacourtiaceae	*Casearia* sp.	X			2578	Understory tree 3 m.
Gesneriaceae	*Cyrtandra* sp.		X		2489	Small shrub 2 m.
Gesneriaceae	*Cyrtandra* sp.	X			2529	Understory herb.
Icacinaceae	*Gonocaryum* sp.			X	2644	Tree 15 m, dbh 12 cm.
Icacinaceae	*Medusanthera laxiflora*			X	2647	Understory tree 8 m.
Icacinaceae	*Pseudobotrys cauliflora*	X			2574	Understory tree 4 m, dbh 6 cm.
Icacinaceae	*Stemonurus monticolus*			X	2653	Understory tree 5 m.
Lauraceae	*Actinodaphne* sp.	X			2589	Understory tree 5 m.
Lauraceae	*Cryptocarya* sp.	X			2546	Tree 15 m, dbh 20 cm.
Lauraceae	*Cryptocarya* sp.	X			2581	Tree 10 m, dbh 12 cm.
Lauraceae	*Cryptocarya* sp.	X			2638	Tree 18 m, dbh 16 cm.

APPENDIX 2 Botanical specimens collected by Colin E. Ridsdale

		SITES				
FAMILY	SPECIES	WAPOGA (1070m)	HP 55 (1890m)	SIEWA (80m)	CER COLLECTION NUMBER	LIFE-FORM
Lauraceae	*Litsea* sp.	X			2576	Tree 18 m, dbh 15 cm.
Lauraceae	*Phoebe* sp.	X			2550	Tree 15 m, dbh 12 cm.
Lauraceae	*Phoebe* sp.	X			2607	Tree 18 m, dbh 20 cm.
Lauraceae	genus indet.	X			2633	tree 18 m, dbh 15 cm.
Leguminosae	*Mucuna gigantea*		X		2497	Slender liane.
Loganiaceae	*Fagraea* sp.	X			2568	Understory tree 4 m.
Loganiaceae	*Geniostoma* sp.	X			2533	Liane to 4 m.
Melastomataceae	*Astronia* sp.		X		2512	Understory tree 4 m.
Melastomataceae	*Medinilla alata*		X		2506	Understory shrub 2 m.
Melastomataceae	*Medinilla hollrungiana*		X		2504	Terrestrial shrub.
Melastomataceae	*Medinilla radicans*			X	2652	Epiphyte at 2 m.
Melastomataceae	*Memecylon* sp.	X			2592	Understory treelet 2 m.
Melastomataceae	genus indet.	X			2626	Epiphytic shrub at 5 m.
Meliaceae	*Chisocheton* sp.	X			2560	Tree 10 m, dbh 15 cm.
Meliaceae	*Dysoxylum* sp.	X			2570	Understory tree 8 m.
Meliaceae	*Dysoxylum latifolium*	X			2588	Large tree 25 m, dbh 60 cm.
Meliaceae	genus indet.	X			2637	Tree 15 m, dbh 12 cm.
Monimiaceae	*Kibara* sp.	X			2618	Understory tree 2 m.
Monimiaceae	*Palmeria* sp.	X			2635	Liane to 8 m.
Monimiaceae	*Palmeria arfakiana*	X			2557, 2597	Siewa Camp climber to 5 m.
Monimiaceae	*Steganthera* sp.	X			2545	Tree 5 m. Swollen ant nodes.
Moraceae	*Artocarpus* sp.	X			2623	Tree 15 m, dbh 12 cm.
Moraceae	*Ficus* sp.			X	2484	Fig in rheophytic zone.
Moraceae	*Ficus* sp.		X		2492	Epiphytic fig.
Moraceae	*Ficus* sp.	X			2624	Climbing fig to 8 m.
Moraceae	*Ficus* sp.			X	2649	Climbing fig to 8 m.
Moraceae	*Ficus* sp.			X	2666	Climbing fig.
Moraceae	*Ficus arbuscula*			X	2483	Common rheophytic fig.
Moraceae	*Ficus arbuscula*	X			2560	Rheophytic fig.
Moraceae	*Streblus* sp.	X			2611	Small tree 5 m.
Myristicaceae	*Horsfieldia sp.*	X			2549	Fallen branch fragment.
Myristicaceae	*Gymnacranthera farquhariana*			X	2664	Tree 15 m, dbh 12 cm.
Myristicaceae	*Horsfieldia subtilis* (Miq.)Warb.			X	2662	Understory tree 4 m.
Myristicaceae	*Myristica* sp.		X		2500	Tree 20m, dbh 35 cm.
Myristicaceae	*Myristica* sp.	X			2627	Tree 12 m, dbh 10 cm.
Myristicaceae	*Myristica fusca* Markgr.			X	2663	Tree 18 m, dbh 25 cm.
Myristicaceae	*Myristica subalulata* Miq.	X		X	2538, 2656, 2665	Small Understory tree 5m.

		SITES				
FAMILY	**SPECIES**	**WAPOGA (1070m)**	**HP 55 (1890m)**	**SIEWA (80m)**	**CER COLLECTION NUMBER**	**LIFE-FORM**
Myristicaceae	*Myristica subcordata* Bl.			X	2650	Tree 18 m, dbh 15 cm.
Myrsinaceae	*Ardisia* sp.	X			2539	Monopodial tree 4 m,
Myrsinaceae	*Discocalyx* sp.	X			2577	Understory treelet 0.5 m.
Myrsinaceae	*Rapanea* sp.	X			2598	Understory shrub 2 m.
Myrsinaceae	*Rapanea* sp.	X			2600	Understory tree 3 m.
Myrtaceae	*Octamyrtus* sp.		X		2517	Multibranched Understory shrub.
Myrtaceae	*Syzygium* sp.	X			2553	Tree 18 m, dbh 15 cm.
Myrtaceae	*Syzygium* sp.	X			2583	Understory tree 5 m.
Myrtaceae	*Syzygium* sp.	X			2587	Tree 18 m, dbh 20 cm,
Myrtaceae	*Syzygium* sp.	X			2596	Small tree 3m.
Myrtaceae	*Syzygium* sp.	X			2631	Tree 18 m, dbh 20 cm.
Pandanaceae	*Freycinetia* sp.	X			2617	Climber to 15 m.
Piperaceae	*Piper* sp.			X	2646	Climbing piper.
Pittosporaceae	*Pittosporum* sp.		X		2515	Tree 15 m, dbh 20 cm.
Pittosporaceae	*Pittosporum ramiflorum*	X			2523	Tree 18 m, dbh 15 cm.
Pittosporaceae	*Pittosporum sinuatum*	X			2591	Understory treelet 1.5 m.
Poaceae	genus indet.	X			2594	Forest herb.
Podocarpaceae	*Dacrycarpus imbricatus*	X			2601	Understory juvenile conifer 3m.
Podocarpaceae	*Dacrydium* sp.	X			2527	Large tree 20 m, dbh 60 cm.
Podocarpaceae	*Podocarpus* sp.	X			2613	Subcanopy tree 8 m, dbh 10 cm
Proteaceae	*Helicia* sp.	X			2530	Fallen branch fragment.
Rhamnaceae	*Zizyphus* sp.			X	2645	Tree 18 m, dbh 20 cm.
Rosaceae	*Prunus* sp.		X		2493	Tree 20 m, dbh 25 cm.
Rosaceae	*Prunus* sp.		X		2514	Tree 20 m, dbh 35 cm.
Rosaceae	*Prunus* sp.	X			2579	Subcanopy tree 12 m
Rubiaceae	*Antirrhoea megacarpa*			X	2659	Tree 15m, dbh 12
Rubiaceae	*Canthium* sp.	X			2563	Understory tree 4 m.
Rubiaceae	*Gardenia* sp.			X	2480	Hemi-epiphyte at 15 m.
Rubiaceae	*Lasianthus* sp.	X			2632	Understory treelet 1.5 m.
Rubiaceae	*Neonauclea* cf. *brassii*	X			2585	Streamside tree 8 m.
Rubiaceae	*Neonauclea lanceolata*	X			2639	Tree 12 m, dbh 10 cm.
Rubiaceae	*Neonauclea obversifolia*			X	2654	Tree 20 m, dbh 40 cm.
Rubiaceae	*Pachystylus gulcheriana*	X			2535	Understory tree 4 m.
Rubiaceae	*Psychotria* sp.			X	2480	Monopodial trelet 2 m.
Rubiaceae	*Psychotria* sp.		X		2505	Shrub 3 m.
Rubiaceae	*Psychotria* sp.	X			2542	Understory shrub 2 m.
Rubiaceae	*Psychotria* sp.	X			2544	Siewa Camp root climber to 5 m.

APPENDIX 2 Botanical specimens collected by Colin E. Ridsdale

		SITES				
FAMILY	SPECIES	WAPOGA (1070m)	HP 55 (1890m)	SIEWA (80m)	CER COLLECTION NUMBER	LIFE-FORM
Rubiaceae	*Timonius* sp.	X			2522	Epiphytic shrub at 10 m.
Rubiaceae	*Timonius* sp.	X			2552	Understory tree 5 m.
Rubiaceae	*Timonius* sp.	X			2562	Climbing liane.
Rubiaceae	*Timonius* sp.	X			2566	Understory tree 5 m.
Rubiaceae	*Timonius* sp.	X			2584	Ephiphytic shrub at 8 m.
Rubiaceae	*Timonius* sp.	X			2590	Understory tree 5 m.
Rubiaceae	*Timonius* sp.	X			2602	Small tree 3 m.
Rubiaceae	*Timonius* sp.	X			2604	Small hemiepiphytic shrub.
Rubiaceae	*Timonius* sp.	X			2640	Tree 12 m, dbh 8 cm.
Rubiaceae	*Timonius belensis* vel aff.		X		2491	Epiphytic shrub.
Rubiaceae	*Urophyllum* sp.	X			2525	Understory monopodial shrub.
Rutaceae	*Halfordia* sp.	X			2569	Understory tree 5 m.
Rutaceae	*Melicope* sp.		X		2485	Tree 15 m.
Rutaceae	*Melicope* sp.		X		2516	Understory tree 15 m, dbh 15 cm.
Rutaceae	*Melicope* sp.	X			2586	Tree 18 m, dbh 20 cm.
Santalaceae	*Scleropyrum* sp.			X	2655	Treelet 2.5 m.
Sapindaceae	*Harpullia cupanioides*			X	2642	Understory tree 4 m.
Saxifragaceae	*Polyosma* sp.		X		2488	Slender tree 12 m., dbh 5 cm.
Solanaceae	*Solanum lasio*			X	2482	Siewa Camp climber to 3 m.
Styracaceae	*Bruinsmia styracoides*	X			2555	Trees 20 m, dbh 12 cm.
Styracaceae	*Bruinsmia styracoides*	X			2615	Tree 15 m, dbh 18 cm.
Symplocaceae	*Symplocos celastrifolia*	X			2567	Large tree 20 m, dbh 30
Symplocaceae	*Symplocos celastrifolia*	X			2603	Tree 12 m, dbh 15 cm.
Theaceae	*Eurya* sp.	X			2551	Understory tree 8 m, dbh 10 cm.
Theaceae	*Gordonia amboinensis*	X			2572	Understory tree 8 m., dbh 10 cm.
Theaceae	*Ternstroemia* sp.	X			2582	Large tree 20 m, dbh 30 cm.
Urticaceae	*Poikilospermum* sp.			X	2651	Climber to 15 m.
Urticaceae	*Procris* sp.		X		2496	Root climber.
Verbenaceae	*Gmelina glandulosa*			X	2661	Tree 15 m, dbh 20 cm.
Vitaceae	*Tetrastigma* sp.		X		2495	Liane.
Vitaceae	*Tetrastigma* sp.	X			2528	Tendril climber to 15 m.
Vitaceae	*Tetrastigma* sp.	X			2614	Tendril climber to 6 m.
Winteraceae	*Zygogynum* sp.	X			2526	Understory tree 4 m.
Winteraceae	*Zygogynum* sp.	X			2625	Small tree 5 m.
Winteraceae	*Zygogynum calothyrsum*		X		2513	Understory tree 4 m.
Zingiberaceae	*Etlingera* sp.			X	2660	Ginger stems to 2.5 m.
family indet		X			2616	

		SITES				
FAMILY	**SPECIES**	**WAPOGA (1070m)**	**HP 55 (1890m)**	**SIEWA (80m)**	**CER COLLECTION NUMBER**	**LIFE-FORM**
family indet		X			2620	Understory shrub 1.5 m.
family indet				X	2643	Tree 15 m, dbh 18 cm.
no specimen RH*			X		2499	Liane.
no specimen RH*			X		2502	Slender climber.
no specimen RH*		X			2561	
no specimen RH*		X			2634	Subcanopy tree 12 m, dbh 10 cm.
no specimen RH*				X	2648	Tree 18 cm, dbh 15 m.

* specimens deposited in the Bogor Herbarium, Bogor, Indonesia

APPENDIX 3 Significant Botanical Records from collections by Colin E. Ridsdale in the Wapoga River Headwaters area, Irian Jaya, Indonesia

Colin E. Ridsdale

Arranged by family.

Annonaceae

The collection *Pseuduvaria* CER 2658 is interesting. This genus of small understory trees is represented in New Guinea by some 12 species, all of which are rarely collected and only known from a few collections. The specimen seems closest to *P. aurantiaca* (Miq.) Merr. which has only been collected once since the original collection of Zippelius from New Guinea in 1828.

Elaeocarpaceae

Unfortunately, identifications of the five collections of *Elaeocarpus* had not been received at the time of writing. *Dubouzetia* CER 2519. The genus is distributed from New Caledonia to New Guinea. In Irian Jaya there is one lowland species and two high montane species, the latter known only from 3 collections. The present collection probably represents a new species.

Guttiferae

Garcinia sp. CER 2536. This was a dominant tree of the riverine forest at Wapoga, in some cases occurring in almost pure stands. At the time of the expedition the tree was fruiting and appeared to be one of the main sources of food for the Cassowary. Numerous large faecal droppings were seen each day, mainly composed of the undigested large seeds of this species.

Melastomataceae

Medinilla alata Backer f. CER 2506. The species is known previously from about 3 collections from the Bird's Head at similar altitudes. *M. hollrungii* Mansf. CER 2504, is widespread in Irian Jaya and PNG. at similar altitudes. *Medinilla radicans* (Bl.) Bl. var. *quadrifolia* (Bl.) Bakh.f. CER2652 is a widespread species extending from Java, Borneo and Philippines to the Solomon Islands. It is interesting that this seems to be the only collection in Rijksherbarium from Irian Jaya and PNG.

Meliaceae

Dysoxylum latifolium Benth. C.E.R. 2588. Together with *Agathis* this species was one of the larger trees in the forest at Wapoga Camp, it was the only species consistently to have heavy epiphyte loading on the branches.

Monimiaceae

Steganthera aff. *hospitans* (Becc.) Kan.& Hat. is one of three New Guinea species of the genus in which the nodes of the stem are swollen and inhabited with ants. The receptacle is greenish-cream with contrasting black fruits. It is it is usually found in riverine forest as the case at Wapoga.

Moraceae

Ficus arbuscula was the major rheophytic shrub in and along the rivers; dense stands of the flat –topped sprays were seen at Siewa and Wapoga.

***Myristicaceae* (W.J.J.O. de Wilde, pers. comm.)**

Horsfieldia sp. CER 2549 from the ridge forest at Wapoga composed of male inflorescences represents a new taxa, either a new species close to *H. pilifera* Markgraf or a new variety of *H. subtilis* Miq.
Myristica sp. CER 2627 from the lower slopes of the ridge forest at Wapoga composed of female flowers and young fruit is probably a new species close to *M. crassipes* Warb.

Verbenaceae

Gmelina glandulosa Hallier f. This rare species from disturbed forest, first described from Banda, Moluccas, is only known from a few collections from the Bird's Head, Bomberai Peninsular and Asmat region. It appeared relatively common in open areas at Siewa.

***Winteraceae* (W. Vink, pers. comm.)**
Zygogynum calothyrsum (Diels) Vink is fairly widespread in New Guinea at similar altitudes.
Interesting are the collections CER 2526 & CER 2625 *Zygogynum* sp., both probably represent undescribed taxa, the former only known from one other collection.

APPENDIX 4 Botanical specimens collected by J. P. Mogea during the RAP survey of the Wapoga area, Irian Jaya, Indonesia.

Johanis P. Mogea

Collecting sites are described in the Introduction and Gazetteer.
Specimens have been deposited in the Bogor Herbarium, Bogor, Indonesia

Authorities are:

W = identified by Mr. Wardi
M = identified by Dr. Mogea

		SITES				
FAMILY	**SPECIES**	**WAPOGA (1070m)**	**HP 55 (1890m)**	**SIEWA (80m)**	**AUTHORITY**	**JPM COLLECTION NUMBER**
Acanthaceae	Herb undet.	X				7111
Acanthaceae	Shrub undet.		X			6999
Actinidiaceae	*Saurauia* sp.		X			7012, 6907
Actinidiaceae	*Saurauia* sp.	X				7113
Adiantaceae	*Adiantum* spp.	X				6920, 7142, 7151
Adiantaceae	*Adiantum* spp.		X			7047, 7053, 7054
Adiantaceae	*Antrophyum* sp.		X			7037
Amaryllidaceae	Herb undet.	X				7125
Apocynaceae	Shrub undet.	X				7096
Apocynaceae	Shrub 2 n tall undet.	X				7119
Apocynaceae	Treelet undet.	X				6934
Aquifoliaceae	*Ilex* sp.		X			7059
Araceae	*Caladium* sp.	X				7162
Araceae	*Cryptocoryne* spp.	X				6948, 7170
Araceae	*Holochlamys beccarii* (Engl.) Engl.	X			W	6935, 6946
Araceae	*Homalomena propinqua*	X			W	7160
Araceae	*Pothos latifolius*	X			W	7200
Araliaceae	*Schefflera* sp.	X				7144
Araucariaceae	*Agathis damara*	X				7135
Arecaceae	*Areca macrocalyx*	X			M	6918, 7083, 7161
Arecaceae	*Borassus heineana*			X	M	7207, 7208
Arecaceae	*Calamus* sp.1		X		M	6902
Arecaceae	*Calamus* sp. 2	X			M	6944
Arecaceae	*Calamus* sp. 3	X			M	7156
Arecaceae	*Calamus* sp. 4	X			M	7158
Arecaceae	*Calamus* sp. 5	X			M	7192
Arecaceae	*Calamus* sp. 6	X			M	7206
Arecaceae	*Calyptrocalyx* sp. 1	X			M	7157

		SITES				
FAMILY	**SPECIES**	**WAPOGA (1070m)**	**HP 55 (1890m)**	**SIEWA (80m)**	**AUTHORITY**	**JPM COLLECTION NUMBER**
Arecaceae	*Gronophyllum micranthum*	X			M	7097, 7179
Arecaceae	*Gronophyllum pinangoides*	X			M	6943, 7154, 7194
Arecaceae	*Gronophyllum* sp. 2	X			M	7193
Arecaceae	*Gronophyllum* sp. 3	X			M	7203
Arecaceae	*Licuala* "*arborea*"	X			M	7178, 7196
Arecaceae	*Licuala* sp. 1	X			M	7099
Arecaceae	*Licuala* sp.1	X				7176
Arecaceae	*Orania lauterbachiana*	X			M	6916, 7098
Aristolochiaceae	*Aristolochia tagala*	X			W	7204
Asclepiadaceae	*Hoya* sp.	X				7180, 7191
Aspleniaceae	*Asplenium* spp.		X			7014, 7024
Asteraceae	*Eupatorium riparium*	X				7172
Asteraceae	*Anaphalis hellwigii*		X		W	7074
Balanophoraceae	*Balanophora papuana*	X				6956, 7043
Begoniaceae	*Begonia hispidissima*	X			W	7164
Begoniaceae	*Begonia isoptera*	X			W	7089
Begoniaceae	*Begonia* sp.	X				7110
Begoniaceae	*Begonia weigalii*			X	W	7209
Burseraceae	Tree undet.	X				7159
Chloranthaceae	*Sarcandra glabra*	X			W	6950
Clusiaceae	*Garcinia* sp.	X				7184
Commelinaceae	*Commelina* sp.		X			7067
Cyatheaceae	*Cyathea* sp.		X			7020
Cyperaceae	*Cyperus* spp.	X				7105, 7188
Davalliaceae	*Davallia* sp.		X			7045
Davalliaceae	*Nephrolepis* sp.		X			7071
Davalliaceae	*Nephrolepis* spp.	X				7100, 7101, 7102, 7114
Dipteridaceae	*Dipteris conjugatum*	X				7117
Elaeocarpaceae	*Elaeocarpus* spp.	X				7185, 7202
Ericaceae	*Vaccinium* spp.	X				7108, 7132, 7148
Euphorbiaceae	*Galearia celebica*		X		W	7061
Euphorbiaceae	Shrub undet.	X				7166
Filicopsida undet.	Climber	X				7116
Filicopsida undet.	Climbing fern spp.		X			6912, 7023, 7072
Filicopsida undet.	Climbing fern spp.	X				6945, 7120, 7181, 7183

APPENDIX 4 Botanical specimens collected by J. P. Mogea

		SITES				
FAMILY	SPECIES	WAPOGA (1070m)	HP 55 (1890m)	SIEWA (80m)	AUTHORITY	JPM COLLECTION NUMBER
Filicopsida undet.	Dwarf tree fern		X			7049, 7063, 7064
Filicopsida undet.	Epiphyte fern spp.		X			6904, 7001, 7002, 7010, 7013, 7018, 7046, 7068, 7069, 7070, 7073
Filicopsida undet.	Epiphytic fern	X				7112
Filicopsida undet.	Epiphytic liana fern		X			7022
Filicopsida undet.	Stemless fern		X			7082
Filicopsida undet.	Stemless terrestrial fern		X			7003, 7004
Filicopsida undet.	Terrestrial fern		X			6909
Filicopsida undet.	Terrestrial fern spp.	X				6936, 6954, 6955, 7090, 7126, 7155, 7182, 7195
Filicopsida undet.	Terrestrial tiny fern		X			6911
Filicopsida undet.	Terrstrial moderate size fern		X			7028
Filicopsida undet.	Tiny fern		X			7038
Filicopsida undet.	Tiny fern on stone		X			6906, 6910
Filicopsida undet.	Tiny terrestrial fern		X			6914
Filicopsida undet.	Tree fern		X			7050
Flagellariaceae	*Flagellaria* sp.	X				7106
Flagellariaceae	*Freycinetia* sp.	X				7199
Gesneriaceae	*Aeschynanthus* sp.	X				7165
Gesneriaceae	*Cyrtandra* sp.		X			7048
Gesneriaceae	*Cyrtandra* spp.	X				6933, 6939
Gesneriaceae	Herb undet.		X			7006, 7008
Lichen	Lichen undet.		X			7034
Liliaceae	*Dianella* spp.	X				7088, 7146
Loganiaceae	*Fagraea* sp.		X			6903
Lycopodiaceae	*Lycopodium* sp.		X			7027
Lycopodiaceae	*Lycopodium* sp.	X				7122
Magnoliaceae	*Talauma* sp.	X				6917, 6919
Marantaceae	*Phrynium* sp.	X				7163
Melastomataceae	Liana undet.	X				7127
Melastomataceae	*Medinilla auriculata*	X			W	7169 a
Melastomataceae	*Medinilla malabatrichum*	X			W	7169 b
Melastomataceae	*Medinilla* sp.	X				7171, 7190, 7197
Melastomataceae	*Medinilla boemiensis* Karr & Matts.	X			W	6931, 7168
Melastomataceae	*Medinilla rubrifructus*		X		W	7042
Melastomataceae	*Medinilla* sp.		X			7058
Meliaceae	*Dysoxylum* sp.	X				7189

		SITES				
FAMILY	**SPECIES**	**WAPOGA (1070m)**	**HP 55 (1890m)**	**SIEWA (80m)**	**AUTHORITY**	**JPM COLLECTION NUMBER**
Meliaceae	Shrub spp.	X				7087, 7167
Moraceae	*Ficus* sp.	X				6957
Moraceae	*Ficus* sp.		X			7080
Myristicaceae	*Knema* sp.	X				6929
Myrsinaceae	*Ardisia* sp.	X				7118
Myrsinaceae	*Ardisia* sp.		X			7026
Nepenthaceae	*Nepenthes* spp.		X			7021, 7044
Nepenthaceae	*Nepenthes* spp.	X				7085, 7187
Orchidaceae	*Bulbophyllum* sp.		X			6901
Orchidaceae	*Bulbophyllum* spp.	X				7121, 7129
Orchidaceae	*Coelogyne* sp.	X				7086
Orchidaceae	*Dendrobium* spp.		X			7051, 7057
Orchidaceae	*Dendrobium* spp.	X				7084, 7128, 7139
Orchidaceae	Epiphytic orchid spp. undet.	X				6922, 7131, 7205
Orchidaceae	Epiphytic orchid spp. undet.		X			7005, 7029, 7035, 7039, 7076
Orchidaceae	*Eria* spp.	X				6921 6942
Orchidaceae	*Goodyera* sp.	X				7140
Orchidaceae	*Phaius* spp.	X				6941, 7130
Orchidaceae	Terrestrial orchid undet.	X				7138
Orchidaceae	Terrestrial tiny orchid undet.	X				7149
Orchidaceae	Tiny orchid undet.	X				7141
Pandanaceae	*Freycinetia* sp.	X				7104
Piperaceae	*Piper estonii* Bailey	X			W	6932
Piperaceae	*Piper* sp.		X			7017
Poaceae	*Dinochloa scandens*?	X				7109
Podocarpaceae	*Phyllocladus hypophillus* Hook. f.	X			M	6938, 7150
Podocarpaceae	*Podocarpus* sp.	X				7134
Polygonaceae	*Polygonum chinense*		X		W	7066
Rhamnaceae	*Colubrina asiatica*		X		W	7077
Rosaceae	*Rubus moluccanus*		X			7011
Rosaceae	*Rubus rosifolius*		X		W	7081
Rubiaceae	*Ixora* sp.	X				7198
Rubiaceae	*Psychotria leleana*	X			W	6947, 6949
Rubiaceae	*Psychotria leptothyrsa*		X		W	6905, 7055
Rubiaceae	*Psychotria* sp.	X				6927
Rubiaceae	Shrub undet.	X				7133

APPENDIX 4 Botanical specimens collected by J. P. Mogea

		SITES				
FAMILY	SPECIES	WAPOGA (1070m)	HP 55 (1890m)	SIEWA (80m)	AUTHORITY	JPM COLLECTION NUMBER
Rubiaceae	*Tarenna fragrans*	X			W	7095
Rubiaceae	*Tarenna* sp.	X				7153
Rubiaceae	*Urophyllum arboreum*	X			W	6951
Saxifragaceae	*Polyosma integrifolia*		X		W	7030
Smilacaceae	*Smilax* sp.	X				7147
Smilacaceae	*Smilax leucophylla* Blume	X			W	6930
Urticaceae	*Elatostema* sp.		X			7078
Urticaceae	*Elatostema* sp.	X				7174
Urticaceae	Herb spp.	X				7173, 7175
Urticaceae	*Urtica* sp.		X			6908
Urticaceae	*Procris pedunculata*	X			W	6952
Zingiberaceae	*Elettaria* spp.		X			7025, 7031, 7032, 7060, 7075
Zingiberaceae	*Elettaria* spp.	X				7091, 7092, 7093, 7094, 7103, 7123, 7124, 7136, 7137, 7152
Zingiberaceae	*Amomum* sp.		X			7016
Zingiberaceae	*Zingiber* sp.		X			7007
Zingiberaceae	*Zingiber* spp.	X				6923, 6924, 6925, 6926, 6937, 6940, 6953
Undetermined	Flower only taken from the ground	X				7186
Undetermined	Herb sp.	X				7107
Undetermined	Herb spp.		X			7000, 7036
Undetermined	Liana spp.	X				6928, 7201
Undetermined	Shrub	X				7145
Undetermined	Shrub 2 - 4 m tall	X				7115
Undetermined	Shrub spp.		X			7009, 7062, 7079
Undetermined	Tree		X			7052
Undetermined	Tree	X				7143
Undetermined	Tree up to 10 m tall		X			7019
Undetermined	Treelet		X			7015
Undetermined Moss	Moss spp.		X			6913, 6915, 7033, 7040, 7041, 7056, 7065

Palms collected in the Wapoga area, Irian Jaya, Indonesia with notes on Irian Jaya palms

APPENDIX 5

Johanis P. Mogea

Areca

The genus consists of about 48 species distributed from India to Solomon Islands, 11 species may occur in New Guinea (Essig, 1977) and so far four species are recorded for Irian Jaya , namely *Areca catechu* L., the wide spread species cultivated for betelnut. The other known species are *A. macrocalyx* Zipp. *ex* Blume, *A. jobiensis* Beccari from Japen Island, and *A. warburgiana* Beccari from Macluer Gulf (Sigar or Sekar).

Our collections from Wapoga (JPM 6918 and 7161) are recognized here as *A. macrocalyx*. The species is planted as ornamentals around the Sheraton Hotel at Timika. In Wapoga the plants were found wildly but not commonly. The plants are solitary, the stem may reach up to 6 m tall, *ca* 5 cm in diameter. Our collections in Bogor Herbarium, Bogor, Indonesia) were taken around Marauke by Versteeg in 1907 (Versteeg 1592 and 1782) and by Meijer Drees in 1938 (Meijer Drees 580). Besides Irian Jaya, the plants are also found in Moluccas such as in Ceram, Tidore, Obi, and Halmahera. A small and slender form of *A. macrocalyx* from Key Islands was described as a variety namely *A. macrocalyx* var. *keyensis* Beccari (1911). According to Essig (1977), the plants are widespread in Papua New Guinea and particularly in cultivation in the highlands as a source of betelnut.

Material examined from Irian Jaya: *Areca macrocalyx* Zipp. ex Blume Kab. Paniai, Wapoga 136^0 28' E - 3^0 08' S, alt. 1150 m, JPM 6918, infructescences, 10.04.1998 (BO, L) and JPM 716*1*, infructescences only, 14.04.1998 (BO). Merauke: Oost Alkmaar Bivak, alt. 30 m, Versteeg 1592, sterile, 09.08.1907 (BO); Bivakeiland, Versteeg 1782, sterile, 06.10.1907 (BO); Bernhard Bivak, alt. 75 m, Meijer Drees 580, infructescences, 13.08.1938 (Dupl.: A, BO, L, K, SING).

Borassus

The genus consists of seven described species, but probably only three or four can be maintained. They occur in Africa, Madagascar, north Arabia, through India and Southeast Asia to New Guinea and Australia (Uhl & Dransfield, 1987). In New Guinea there is only one species namely *B. heineana* Becc. The plant was first known from Sepik River in East Sepik District. Recently collected from Sarmi in 1992 by Mcdonald & Ismail, near Jayapura. Our collections (JPM 7207 and 72208) are from Seiwa in the lowland rainforest at the rather swampy area, at altitude 65 m.

Material examined : Yayapura, Sarmi, Mcdonald & Ismail 3763, fr.11.12.1992 (BO); Piniai, Seiwa, alt. 65 m, $30^02'$ S - $136^022'$ E, JPM 7207, fl.18.04.1998 (BO); JPM 7208, fruit only,18.04.1998 (BO).

Calamus

The genus contains about 370 species worldwide. In New Guinea and the Bismarck Archipelago there are about 50 species. In Irian Jaya 16 described species of *Calamus* are known to occur. These are:

01. *C. arfakianus* Becc. from Arfak Mtns (Anggi Lakes)
02. *C. barbatus* Zipp. from southcoast
03. *C. heteracanthus* Zipp. from southcoast
04. *C. hollrungii* Becc. from Sepik River
05. *C. humboldtianus* Becc. from Humboldt Bay
06. *C. interruptus* Becc. from Vogelkop Penins.
07. *C. klossii* Ridley from Sudirman Mtns. (Mt. Carstenz)
08. *C. mayrii* Burr. from Wandamen Penins. (Wandensi Mtns.)
09. *C. moszkowskianus* Becc. from Rees Mtns.
10. *C. papuanus* Becc. from Vogelkop Penins.
11. *C. pilosissimus* Becc. from Noord River
12. *C. prattianus* Becc. from Arfak Mtns. (Anggi Lakes)
13. *C. serrulatus* Becc. from Vogelkop Penins. (Ramoi)
14. *C. steenisii* Furtd. from unknown locality
15. *C. vestitus* Burr. from Andai
16. *C. zebrinus* Becc. from Vogelkop Penins. (Ramoi)

Our collections of *Calamus* from Wapoga (5 numbers) and Helipad 55 (1 number) are recognized as *C. humboldtianus* and *C. hollrungii.* The former is endemic but widespread from Irian Jaya to Papua New Guinea and was first known from Humboldt Bay. The RAP specimens are the second taken from Irian Jaya in the Bogor collection. The second species is widespread from Moluccas to Irian Jaya where it seems to be widespread despite this being the first collection of the species from Irian Jaya in the Bogor collection. The other four numbers of our collection do not match any of the 16 rattan species known from Irian Jaya available in Bogor (see material examined). *Calamus sp.1* and *Calamus sp.4* have flagellum, *Calamus sp2* and *Calamus sp. 3* have cirrus. These collection need further examination using large collections and type specimens found in Kew, Leiden, and Florence (Firenze).

Material examined: *Calamus heteracanthus*: Moluccas: N. Moluccas, Halmahera, Weda, Desa Kobe, Vern. : Kiom Kumel (Sawai Lang.), bb. 35003 de Haan*,* fl.19.01.1952; *ditto*., Ekor, Bukit Dowana, Vogel 3256, st.30.09.1974 (L); *ditto*., Obi Isl., Anggai, Gunung Batu Putih, Vogel 4019*,* fl.13.11.1974 (L). *Calamus hollrungii*: Moluccas: Halmahera, Pulu Rao, Loleo, Beguin 1826, fr.15.10.1921; *ditto*., Soa Tobaru, Vern.: Iwitui, Beguin 2097, fr.29.07.1922; Sula, Sanana, Desa Kabauw, Vern.: Uwa Jawa, bb. 28882 Bloembergen 378, fr.15.08.1939; *ditto.,* bb. 28881 Bloembergen 377, fl.15.08.1939. Ternate, alt. 350 m, Vern.: Urigoro (Ternate lang.); *ditto.,* North of Rua, alt. 450 m, Vern.: Dahaigosi (Tidore lang.), Beguin 1661, fl, s.d.; ditto., Beguin 77*1*, st.26.06.1920. Sula Mangoli, *v.* Hulstijn 391, st.s.d. Papua New Guinea, Lake Daviumbu, middle Fly River, Brass 7492, fr.00.08.1936; Painai, Wapoga,
JPM 6944, fl.. 11.04.1998. *Calamus humboldtianus* : Near Jayapura, Kostermans & . Soegeng 166, fl.04.08.1966. *Calamus pilosissimus* : Noord River, Versteegh 1701, st.09.09.1907. *Calamus prattianus*: Arfak Mtns., Anggi Lakes; Kab. Jayawijaya, Kurukulu, Air Garam, Wiriadinata 4613, st.10.02.1991; *Calamus sp.1,* Paniai, Helipad 55, JPM 6902, fr.08.04.1998. *Calamus sp.2*, Wapoga, JPM 7158, st.14.04.1988. *Calamus sp. 3 :* Wapoga, JPM 7192, 16.04.1988. *Calamus sp. 4*: Wapoga, JPM 7206*,* st.17.04.1988.

Calyptrocalyx

The genus consists of 21 species, 8 are found in Irian Jaya:
01. *P. arfakianus* (Beccari) Burret,
02. *P. flabellata* (Beccari) Burret,
03. *P. multifida* (Beccari) Burret both three are from Arfak Mountains,
04. *P. caudiculata* (Beccari) Burret from south coast,
05. *P. geonomiformis* (Beccari) Burret from Mt. Resi,
06. *P. leptostachys* (Burret) Burret from Cyclops Mountains,
07. *P. pachystachys* (Burret) Burret from Waigeo Island, and
08. *P. pauciflora* (Ridley) Burret from Mt. Carstenz (Essig, 1977).

Our collection of *Calyptrocalyx* sp. (JPM 7157) is a rather common species in Wapoga. However, the species is still unidentified as in BO we have only two New Guinean *Calyptrocalyx* namely *C. albertianus* Beccari and *C. spicatus* which are both are unlikely match to the specimens collected from Wapoga.

Material examined: *Calyptrocalyx sp.1* from Irian Jaya, Kab. Paniai, Wapoga , JPM 7157, infructescences, 10.04.1998 (BO, L). The plant solitary*,* stem up to 7 m long, ca 7 cm in diameter, leaves ca 9 on crown. *C. archboldianus* Burr. from Papua New Guinea, Central Division, limestone forest, alt. 1350 m, Brass 5290 (BO - isotype). *C. elegans* Becc from Irian Jaya, Membramo, Feuilletan de Bruyn 228, fr.08.12.1914. *C. micholitzii* (Ridl.) Dowe & Ferrero, the plant originally from Papua New Guinea and cultivated in Bogor Botanic Garden XII.E.7.

Gronophyllum

The genus consists of 33 species distributed from Sulawesi through the Moluccas to New Guinea, the Bismarck Archipelago, and Australia. The plants occur from the lowland at sea level to montane mossy forest as undergrowth palms to emergents, on a variety of substrates including serpentine and limestone. Taxonomically the genus delimitation is not so satisfactory and it is almost confused with the complex of *Hydriastele* and *Gulubia* (Uhl & Dransfield, 1987). So far the *Gronophyllum* recorded for Irian Jaya are:

01. *G. affinis* (Becc.) Essig & Young from Kapaor,
02. *G. densiflora* (Ridley) Essig & Young from Mt. Carstenz
03. *G. flabellata* (Becc.) Essig & Young from Vogelkop Peninsula (Ramoi),
04. *G. gibbsiaum* (Becc.) H.E. Moore from Arfak,
05. *G. luridum* Becc. from Mt. Resi,

06. *G. mayrii* (Burr.) H.E. Moore from Cyclops Mtns.,
07. *G. micrantha* (Burr.) Essig & Young from Wondiwoi Mtns.,
08. *G. montana* (Becc.) Essig & Young from Arfak Mtns.,
09. *G. pinangoides* (Becc.) Essig & Young from Vogelkop Peninsula,
10. *G. procerum* (Blume) H.E. Moore from south coast,
11. *G. pterophylla* (Becc.) Essig & Young from Irian Jaya but the exact locality unknown, the plant described from a cultivation.

The collections from Wapoga are as follows: *Gronophyllum micranthum* (JPM 7097, 7179), *G. pinangoides* (JPM 6943, 7194), *Gronophyllum sp.1* (JPM 7083), *Gronophyllum sp.2* (JPM 7193), and *Gronophyllum sp.3* (JPM 7203). *G. pinangoides* is widespread from Manokwari to Snow Mountains from sea level up to alt. 1350 m.

Material examined: *G. micranthum* from Irian Jaya, Wandamen (Wondimoiberg), alt. 1400 m, Mayr 253, fl.08.07.1928 (BO). *Gronophyllum* sp. from Irian Jaya, Idenberg river, 8 km SW of Bernhard Camp, Brass 13742, fr.00.02.1939 (BO). *G microcarpum* from Irian Jaya, Paniai, Dalman, 45 km inward of Nabire, in *Agathis* forest, alt. 500 m, Kanehira & Hatusima *s.n.,* young fr.02.03.1940 (BO). *G. pinangoides* from Irian Jaya: Manokwari, Prafi SP VI, Widjaja & Hamzah EAW 3135.fr.29.12.1985 (BO); Paniai, Wapoga, alt. 1150 m, JPM 7194, infructescences, 16.04.1998 (BO, L); Snow Mountains region, East of the Baliem valley, Kab. Jayawijaya, Kec. Kurima, alt. 1350 m, Milliken 1423, fl. 00.10.1992 (BO, K). Exact locality unknown : Pulle 427, fl.+fr. 25.11.1912/ 1913 (BO); Pulle 510. fl. in bud. 30.11.1912/1913 (BO); Pulle 522, fr.01.12.1911/1913 (BO).

Licuala

The genus consists of about 130 species mainly occuring in Southeast Asia, the distribution is as far as Thailand, Cambodia, Laos, Vietnam, south China, Myanmar, Bangladesh, northeast India, and the Andaman Islands to Malay Peninsula, Singapore, Indonesia, Philippines, Papua New Guinea, the Solomon Islands, and Queensland (Australia). The Malay Peninsula contains 41 species (Saw, 1997). In Irian Jaya there are 20 species and Papua New Guinea 16 species. Among the 20 species from Irian Jaya, the BO has 5 species namely *L. bellatula* Becc., *L. brevicalyx* Becc., *L.concina* Burr., *L. debilis* Beec., *L. pachycalyx* Burr., and *L. tanycola* H.E. Moore. None of the species above are match to the collection JPM 7099 and 7176 (*Licuala* sp.1) and the *Licuala* "arborea" (JPM 7178 and 7196).

Licuala sp.1 is a dwarf species, stemless, in clump, leaf ca 20 in crown, petiole up to 1.60 m long, blade ca 80 cm in diameter, 7 - 9 leaflets on either side, infructescence erect at the base and at the middle curved and at the top pendulous, up to 30 cm long, fruit young, globose, yellow 0.5 cm in diameter. The plant was rather rare.

The other taxon might be an undescribed tree, *Licuala* "*arborea*", the plant solitary, stem up to 6.7 m tall, stem ca 15 cm in diameter. Leaves ca 12 in crown, petiole 2.2 m long, blade 1.9 m in diameter, leaflet 8 on either side, terminal leaflets obtriangular, 105 by 75 cm, inflorescence pendulous, slender up to 260 cm long, number of secondary axis 10, the largest one at the base of the inflorescence about 50 cm long. Ripe fruit, ellipsoid, 6 cm long, orange to bright red, seed surfaces rough as the seed of *Elaeocarpus*.

Material examined: Irian Jaya, Paniai, Wapoga, alt. 1400 m, JPM 7176, fr. 16.04.98 = *Licuala sp. 1*; *ditto.* JPM 7178, fr. 15.04.98; *ditto.*, JPM 7196 fr only, 16.04.98 = *Licuala "arborea"*. Living collection in Bogor Botanic Garden after *L. lauterbachii* (V.H.92) and *L. penduliflora* (XII.A.44), both are originally from New Guinea, and *L. ramsayi* (XIII.L.150) originally from Queensland Australia.

Orania

The genus consists of about 17 species, distributed in south Thailand, Malay Peninsula, Sumatra, Java, Borneo, Philippines, Sulawesi, Moluccas, New Guinea, and one species in Madagascar, the greatest diversity occurring in New Guinea, with minor radiation in the Philippines (Uhl & Dransfield, 1987). There are 9 species known in New Guinea including Irian Jaya where only one species is recorded, the widespread *Orania lauterbachiana* (Essig, 1980). Our collections (JPM 6918 and 7098) match *O. lauterbachiana* (Essig, 1980), formerly collected from Manokwari, Nabire, and Idenberg River.

Material examined (*Orania lauterbachiana)*: Near Warren, 60 miles south of Manokwari, in high rainforest, alt. 5 m, Kanehira & Hatusima 12967, fl.02.03.1940 (A,BO) ; near Dalman, 45 km inward of Nabire, in *Agathis* forest, alt. 500 m, Kanehira & Hatusima 12128 (not seen in A); Idenberg River, 4 km southwest of Bernhard Camp, occasional in the rainforest of the river plains, alt. 850 m, Brass 13375, fr.00.03.1939 (A, BO, L), *ditto.,* 15 km southwest of Bernhard Camp, common in rainforest substage, alt. 1500 m, Brass 12407, fl.+fr.00.01.1939 (A, BO).

APPENDIX 6 Sampling stations for aquatic insect surveys in the Wapoga River basin in northwestern Irian Jaya, Indonesia

Dan Polhemus

The numbering of the sampling stations begins with Station 41 in order to be consecutive with previous samples made in the course of PTFI supported surveys in the Ajkwa Basin surrounding Timika, at Etna Bay, and at Bilogai.

Station 41: Ponds next to airstrip at Siewa Base Camp, 60 m, water temp. 28.5° C., 3 April 1998, 10:30–11:15 hrs. and 17 April 1998, 09:30–11:00 hrs. 3° 02.21' S, 136° 22.56' E.

Station 42: Cobble bottomed overflow channels adjoining Tirawiwa River, 0.5 km. W. of Siewa Base Camp, 60 m, water temp. 28° C., 3 April 1998, 12:00–15:15 hrs., and 4 April 1998, 13:00–16:30 hrs. 3° 02.66' S, 136° 22.34' E.

Station 43: Ponded rainforest stream near Siewa Base Camp, 60 m, water temp. 26.5° C., 4 April 1998, 09:00–10:05 hrs. 3° 02.21' S, 136° 22.56' E.

Station 44: Standing pool in rainforest, 0.5 km. N. of Siewa Base Camp near old logging road, 60 m, water temp. 27° C., 4 April 1998, 10:30–11:15 hrs. 3° 01.97' S, 136° 22.23' E.

Station 45: Rainforest stream approx. 0.5 km. E. of Siewa Base Camp, 60 m, water temp. 26° C., 5 April 1998, 08:00–11:00 hrs.; 11 April 1998, 09:00–11:00 hrs.; 13 April 1998, 09:30–11:00 hrs.; 17 April 1998, 10:00–11:30 hrs. 3° 02.14' S, 136° 22.66' E.

Station 46: Swift tributary to Logari River, approx. 1.0 km. W. of Landing Site 21, 300 m, water temp. 24.5° C., 6 April 1998, 09:00–11:00 hrs. 3°00.55' S, 136°33.13' E.

Station 47: Rocky tributary to Logari River, approx. 0.5 km. W. of Landing Site 21, 295 m. (970 ft.), water temp. 25° C., 6 April 1998, 12:30–14:30 hrs. 3° 00.45' S, 136° 33.23' E.

Station 48: Logari River and tributaries at Landing Site 21, 290 m, water temp. 24° C. (main river), 7 April 1998, 09:00–14:00 hrs.; 8 April 1998, 09:00–12:00 hrs. 3° 00.35' S, 136° 33.34' E.

Station 49: Clear roadside pond, 1.2 km. N. of Siewa Base Camp along old logging road, 60 m, water temp. 30° C., 9 April 1998, 12:00–13:00 hrs. 3° 01.74' S, 136° 22.14' E.

Station 50: Tirawiwa River and overflow channel at abandoned Wapoga Timber Company camp, 2.0 km. S. of Siewa Base Camp, 60 m, water temp. 27° C., 10 April 1998, 08:30–11:30 hrs. 3° 03.32' S, 136° 23.51' E.

Station 51: Tributary to Tirawiwa River, 4.5 km. N. of Siewa Base Camp along old logging road, 55 m, water temp. 26° C., 12 April 1998, 09:30–12:30 hrs. 3° 00.58' S, 136° 20.97' E.

Station 52: Tributary to Siewa Camper Wapoga River running in limestone bed, near Wapoga Staging Area, 10 m, water temp. 26° C., pH 8.3, 14 April 1998, 07:00–09:30 hrs. 2° 43.40' S, 136° 26.00' E.

Station 53: Muddy lowland forest tributary to Siewa Camper Wapoga River, downstream from Wapoga Staging Area, 5 m, water temp. 27° C., 14 April 1998, 13:00–15:30 hrs. 2° 44.03' S, 136° 04.89' E.

Station 54: Lower Wapoga River and mouth of slow blackwater tributary, upstream from Wapoga Staging Area, 5 m, water temp. 27° C., 15 April 1998, 09:30–11:00 hrs. 2° 45.32' S, 136° 06.53' E.

Station 55: Tributary to Siewa Camper Wapoga River running in limestone bed, downstream from Wapoga Staging Area near Wapoga Timber Company base camp, 10 m, water temp. 26.5° C., pH 8.4, 15 April 1998, 15:00–16:00 hrs. 2° 42.38' S, 136° 05.40' E.

Station 56: Rocky rainforest tributary to upper Ziwa River at Wapoga Alpha Camp, 1050 m, water temp. 20° C., 18 April 1998, 10:00–17:00 hrs.; 19 April 1998, 14:00–18:00 hrs. 3° 08.69' S, 136° 34.42' E.

Station 57: Upper Ziwa River at Wapoga Alpha Camp, 1050 m, water temp. 19° C., 19 April 1998, 08:00–12:00 hrs. 3° 08.69' S, 136° 34.42' E.

Station 58: Swift tributary to upper Ziwa River at Wapoga Alpha Camp, 1050 m, water temp. 20° C., 19 April 1998, 12:30–13:30 hrs. 3° 08.69' S, 136° 34.42' E.

APPENDIX 7

Aquatic insects collected at each of eighteen sampling stations (numbered 41-58) in the Wapoga area, Irian Jaya, Indonesia.

Dan Polhemus

Each station is described in Appendix 2.

Where specific determinations could not be made, the following abbreviations are employed:

n. sp. - indicates that a detailed morphological comparison with known species has determined that the taxon is definitely a species new to science. A number after the new species designation indicates a discrete morphospecies.

sp. undet. - indicates that the species has not yet been definitively identified, and may possibly be undescribed, or simply unidentifiable given the limitations of the current taxonomic literature. As above, a number after the "sp. undet." designation indicates a discrete morphospecies.

genus and species undet. - indicates that the species cannot be identified beyond the family or subfamily level, usually due to limitations of the current taxonomic literature or available comparative collections.

Major sampling areas are the four general regions where collecting stations were located.

T	Tirawiwa River
W	Siewa Camp or Wapoga River
L	Logari River
Z	Ziwa River

STATION NUMBER:	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
MAJOR SAMPLING AREA:	T	T	T	T	T	L	L	L	T	T	T	W	W	W	W	Z	Z	Z
COLEOPTERA																		
DYTISCIDAE																		
Genus and sp. undet.	X	X		X					X							X	X	
GYRINIDAE																		
Gyrinus sp. undet.									X									
Macrogyrus sp. undet.							X	X								X	X	
Merodineutes sp. undet.		X				X	X									X	X	X
Rhombodineutes sp. undet.										X								X
Spinosodineutes sp. undet.																X	X	X
HETEROPTERA																		
BELOSTOMATIDAE																		
Appasus eques (Dufour)	X			X					X									
CORIXIDAE																		
Micronecta sp. undet.					X													
GELASTOCORIDAE																		
Nerthra sp. undet.					X												X	
GERRIDAE																		
Iobates affinis (Esaki)		X						X			X							
Limnogonus darthulus (Kirkaldy)		X	X	X					X	X								
Limnogonus fossarum (Fabricius)	X																	
Limnogonus papuensis Andersen	X								X									
Limnometra ciliata Mayr				X					X									
Limnometra kallisto (Kirkaldy)			X	X		X	X	X				X				X		
Limnometra lipovskii Hung. & Matsuda		X	X	X	X				X		X		X	X	X			
Limnometra sp. undet. (sight record)	X																	
Metrobatopsis sp. undet.					X	X					X	X			X			
Ptilomera n. sp. #1		X			X	X	X	X		X								
Ptilomera n. sp. #2																X		X
Rheumatometroides n. sp.													X	X				
Tenagogonus sp. undet.					X	X	X	X			X	X	X		X	X	X	
HEBRIDAE																		
Hebrus sp. undet. #1		X						X										
Hebrus sp. undet. #2						X						X				X	X	
HYDROMETRIDAE																		
Hydrometra horvathi Hungerford & Evans		X		X	X				X		X				X			
Hydrometra lineata Eschscholtz	X																	
Hydrometra sp. undet.														X				

APPENDIX 7

Aquatic insects collected

STATION NUMBER:	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
MAJOR SAMPLING AREA:	**T**	**T**	**T**	**T**	**T**	**L**	**L**	**L**	**T**	**T**	**T**	**W**	**W**	**W**	**W**	**Z**	**Z**	**Z**
MESOVELIIDAE																		
Mesovelia melanesica Polh. & Polh.											X							
Mesovelia subvittata Horvath								X										
Mesovelia vittigera Horvath	X	X		X					X									
NAUCORIDAE																		
Aphelocheirus pallens Horvath														X				
Aptinocoris papuus Montandon					X			X										
Aptinocoris sedlaceki La Rivers		X			X													
Aptinocoris n. sp.																X		
Cavocoris n. sp (allied to *bisulcus* La Rivers)					X			X										
Sagocoris biroi Mondanton					X			X										
Sagocoris n. sp.		X					X											
Idiocarus intermedius La Rivers																	X	
Idiocarus papuus Polhemus & Polhemus		X			X		X	X										
Idiocarus n. sp. #1 (nr. *minor* La Rivers)																X	X	
Idiocarus n. sp. #2 (nr. *papuus* P. & P.)																X		
Nesocricos sp. undet.																	X	
Tanycricos n. sp. #1																X	X	
Tanycricos n. sp. #2																	X	
NEPIDAE																		
Cercotmetus dissidens Montandon		X			X													
Ranatra diminuta Montandon		X							X									
Ranatra megalops Lansbury				X														
NOTONECTIDAE																		
Anisops kuroiwae Matsumura	X																	
Anisops sp. undet. #1				X					X									
Anisops sp. #2	X		X	X				X	X									
Anisops sp. #3	X																	
Anisops sp. #4	X																	
Enithares loria Brooks	X																	
Enithares sp. undet. #1				X					X									
Enithares sp. undet. #2	X			X			X	X								X	X	
OCHTERIDAE																		
Ochterus n. sp. #1		X																
Ochterus n. sp. #2						X	X	X										
Ochterus n. sp. #3												X						X

STATION NUMBER:	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
MAJOR SAMPLING AREA:	T	T	T	T	T	L	L	L	T	T	T	W	W	W	W	Z	Z	Z
Ochterus n. sp. #4																X	X	
Ochterus n. sp. #5																X	X	
SALDIDAE																		
Saldula ornatula (Reuter)	X																	
VELIIDAE																		
Aegilipsicola n. sp.																X	X	
Microvelia n. sp. #1	X		X	X														
Microvelia n. sp. #2		X								X	X		X	X	X			
Microvelia n. sp. #3					X	X	X	X										
Microvelia n. sp. #4								X								X		
Microvelia n. sp. #5											X							
Microvelia n. sp. #6																X		
Microvelia n. sp. #7	X																	
Microvelia n. sp. #8						X												
Microvelia n. sp. #9						X												
Microvelia n. sp. #10								X										
Microveliinae n. gen. and sp. ("*Papuavelia*")																X		
Microveliinae gen. and sp. undet.																	X	
Neusterensifer sepik Polh. & Polh.		X					X	X		X								
Rhagovelia n. sp. #1 (*caesius* group)		X								X								
Rhagovelia n. sp. #2 (*caesius* group)		X								X								
Rhagovelia n. sp. #3 (*papuensis* group)					X	X		X		X	X				X			
Rhagovelia n. sp. #4 (*novacaledonica* group)						X	X	X								X	X	
Rhagovelia n. sp. #5																X		
Rhagovelia n. sp. #6																X	X	X
Rhagovelia n. sp. #7																	X	
Rhagovelia n. sp. #8																	X	
Rhagovelia n. sp. #9 (*novacaledonica* group)						X		X										X
Strongylovelia albicollis Esaki					X	X	X	X			X	X				X		
Tarsovelia n. sp.							X									X	X	X
ODONATA																		
AGRIONIDAE																		
Neurobasis ianthipennis Lieftinck						X	X	X										
Neurobasis sp. undet. (immature only)		X																

APPENDIX 7

Aquatic insects collected

STATION NUMBER:	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
MAJOR SAMPLING AREA:	T	T	T	T	T	L	L	L	T	T	T	W	W	W	W	Z	Z	Z
CHLOROCYPHIDAE																		
Rhinocypha tincta amanda Lieftinck					X	X	X	X			X							
COENAGRIONIDAE																		
Agriocnemus aderces Lieftinck	X			X					X									
Palaiargia sp. undet.						X		X								X		
Papuagrion sp. undet.					X			X										
Pseudagrion farinicolle Lieftinck		X			X					X								
Pseudagrion ignifer Lieftinck										X								
Pseudagrion microcephalum (Rambur)	X	X																
Teinobasis scintillans Lieftinck																X		
Teinobasis rufithorax (Selys)			X		X													
Teinobasis (?) n. sp.					X													
LESTIDAE																		
Lestes tenuissimus (Tillyard)		X																
MEGAPODAGRIONIDAE																		
Argiolestes sp. undet. #1(nr. *lamprostomus*)					X			X								X		
Argiolestes sp. undet. #2						X	X											
Argiolestes sp. undet. #3																X		
PLATYCNEMIDIDAE																		
Idiocnemus obliterata Lieftinck					X	X	X	X										
Idiocnemus sp. undet. #1								X								X		
PLATYSTICTIDAE																		
Drepanosticta sp. nr. *clavata* Lieftinck																X		
PROTONEURIDAE																		
Nososticta beatrix (Lieftinck)					X													
Nososticta plagioxantha (Lieftinck)					X		X	X										
Nososticta nigrofasciata (Lieftinck)					X							X						
Nososticta sp. undet. #1		X			X					X	X							
Nososticta sp. undet. #2							X											
Nososticta sp. undet. #3												X						
Total Gyrinidae	0	1	0	0	0	1	2	1	1	1	0	0	0	0	0	3	3	3
Total Heteroptera	15	17	5	13	16	13	12	21	11	7	10	6	4	5	6	20	18	5
Total Zygoptera	2	5	1	1	11	5	6	8	1	3	2	2	0	0	0	6	0	0

Ants recorded at two camps in the Wapoga area, Irian Jaya, Indonesia

APPENDIX 8

Roy R. Snelling

Species not previously recorded from Indonesia (and hence are first records for Indonesia) are recorded with an asterisk (*). Species found also at the Lakekamu Basin, PNG (Snelling 1998) are denoted with double asterisk (**).

STRATA

In the last two columns the same scheme is followed here as was used in my prior report on Lakekamu Basin ants (Snelling 1998), based on the terminology introduced by Wilson (1959b), who recognized three distinctive strata:

1 = The *ground stratum* comprises those species that nest in the soil, leaf litter, and all rotting wood on the ground, up to and including the largest rotting logs. The majority of species and genera live at this level and relatively few species leave to forage in the arboreal zones.

2 = The *low arboreal stratum* includes species that nest in herbaceous and shrubby ground vegetation and up to the first several meters of the trunks and branches of larger trees. A small number of species nest primarily or exclusively in this zone and species commonly forage down to the ground stratum.

3 = The *high arboreal stratum* species nest in the upper trunks and canopy of trees; ants nest within epiphytes, abandoned termitaria, and in preformed cavities in both living and dead wood, including twigs. Although most of these species confine their foraging activities to the high canopy, some do forage down into the lower arboreal stratum, less commonly to the ground stratum.

ECOLOGY

While ants are generally looked on as general scavenger-predators, there are some that are specialists, either at the specific or generic level. I classify their foraging ecology into specialist predators **(S)**, general predators **(G)**, pastoralists **(P)**, and seed harvesters **(H)**.

APPENDIX 8 Ants recorded at two camps in the Wapoga area

SPECIES	SIEWA (80m)	WAPOGA (1070m)	STRATA	ECOLOGY
AENICTINAE				
001 * *Aenictus huonicus* Wilson **	x	x	1	S
002 *Aenictus* sp. 1 (male)	-	x	1	S
003 *Aenictus* sp. 2 (male) **	x	-	1	S
004 *Aenictus* sp. 3 (male)	x	-	1	S
005 *Aenictus* sp. 4 (male)	x	-	1	S
006 *Aenictus* sp. 5 (male)	-	x	1	S
CERAPACHYINAE				
007 *Cerapachys superatus* Wilson	x	-	1	S
008 *Cerapachys* sp. 1 (male)	x	-	1	S
009 *Cerapachys* sp. 2 (male)	x	-	1	S
010 *Cerapachys* sp. 3 (male)	x	-	1	S
DOLICHODERINAE				
011 *Anonychomyrma scrutator* (F. Smith)**	-	x	2	G, P
012 *Anonychomyrma* sp. 2	x	x	2	G
013 *Iridomyrmex* sp. (*anceps* group) **	x	-	1	G, P
014 *Leptomyrmex flavitarsis* (F. Smith) ? **	x	x	1	G
015 *Leptomyrmex puberulus* Wheeler	x	-	1	G
016 *Leptomyrmex* sp. cf. *fragilis* (F. Smith)	-	x	1	G
017 *Leptomyrmex fragilis* (F. Smith) **	x	-	1	G
018 *Philidris* sp.	-	x	2	G
019 *Tapinoma melanocephalum* (Fabricius)**	x	-	1	G, P
020 *Technomyrmex albipes* (F. Smith)**	-	x	2	G, P
021 *Technomyrmex* sp.	x	-	2?	G
FORMICINAE				
022 *Acropyga* sp.	x	-	1	P
023 *Camponotus dorycus* F. Smith **	x	x	1	G
024 *Camponotus quadriceps* F. Smith **	x	-	2	G
025 *Camponotus vitreus* F. Smith **	x	-	3	G
026 *Camponotus* sp. 1 (*mussolinii* group)	-	x	2, 3	G
027 *Camponotus* sp. 2	x	-	2, 3	G
028 *Camponotus* sp. 3	x	-	2, 3	G
029 *Camponotus* sp. 4	-	x	2, 3	G
030 *Camponotus* sp. 5	-	x	2, 3	G
031 *Camponotus* sp. 6	-	x	2, 3	G
032 *Camponotus* sp. 7	x	-	2, 3	G
033 *Oecophylla smaragdina* (Fabricius) **	x	x	3	G, P
034 * *Paratrechina minutula* (Emery) **	x	x	1	G
035 * *Paratrechina pallida* Donisthorpe **	x	-	1	G
036 * *Paratrechina* cf. *opaca* (Emery)	x	-	1	G
037 *Paratrechina* sp. 1	x	-	1	G

SPECIES	SIEWA (80m)	WAPOGA (1070m)	STRATA	ECOLOGY
038 *Paratrechina* sp. 2	x	x	1	G
039 *Paratrechina* sp. 3	-	x	1	G
040 *Paratrechina* sp. 4	-	x	1	G
041 *Polyrhachis aurita* Emery	-	x	2, 3	G
042 *Polyrhachis* cf *breviorspinosa* Donis.	x	-	2, 3	G
043 *Polyrhachis erosispina* Emery	x	-	2, 3	G
044 *Polyrhachis* cf. *exarata* Emery	-	x	2, 3	G
045 *Polyrhachis greensladei* Kohout	-	x	2, 3	G
046 *Polyrhachis linae* Donisthorpe	-	x	2, 3	G
047 *Polyrhachis menozzii* Karavaiev	-	x	2, 3	G
048 *Polyrhachis mucronata* F. Smith	x	-	2, 3	G
049 *Polyrhachis obtusa* Emery	x	-	2, 3	G
050 *Polyrhachis queenslandica* Emery	x	x	2, 3	G
051 *Polyrhachis rufofemorata* F. Smith **	x	-	2, 3	G
052 *Polyrhachis* cf. *scutulata* F. Smith	-	x	2, 3	G
053 *Polyrhachis sericata* (Guerin-Meneville)**	x	-	2, 3	G
054 *Polyrhachis similis angustior* Viehmeyer	-	x	2, 3	G
055 *Polyrhachis subaenescens* Viehmeyer	x	-	2, 3	G
056 *Polyrhachis trina* Donisthorpe	-	x	2, 3	G
057 *Pseudolasius* sp. **	x	x	1	P
MYRMICINAE				
058 *Adelomyrmex biroi* Emery **	x	x	1	G?
059 *Aphaenogaster loriai* (Emery)	x	-	1	G
060 *Aphaenogaster* sp. *(*male*)*	x	-	1	G
061 *Cardiocondyla paradoxa* Emery **	x	-	1	G
062 *Cardiocondyla* sp. 2 *(undescr.)*	-	x	1	G
063 *Crematogaster paradoxa* Emery **	x	-	2	G
064 *Crematogaster* sp. 1	x	-	1	G
065 *Crematogaster* sp. 2	x	-	2	G
066 *Crematogaster* sp. 3	x	-	1	G
067 *Crematogaster* sp. 4 **	x	-	2	G
068 *Crematogaster* sp. 5 **	x	-	1?	G
069 *Crematogaster* sp. 6	x	-	1?	G
070 * *Dacetinops ignotus* Taylor **	x	-	1	G
071 *Eurhopalothrix procera* (Emery) **	x	-	1	S?
072 * *Eurhopalothrix punctata* (Szabó) **	x	x	1	S?
073 * *Eurhopalothrix szentivanyi* Taylor **	x	-	1	S?
074 *Lordomyrma* n. sp. 1 (Taylor MS) **	x	-	1	?
075 *Lordomyrma furcifera* Emery	x	-	1	?
076 *Lordomyrma* n. sp. 4 (Taylor MS)	-	x	1	?
077 *Genus* cf *Lordomyrma,* n. sp. (Taylor MS)	x	-	1	?

APPENDIX 8 Ants recorded at two camps in the Wapoga area

	SPECIES	SIEWA (80m)	WAPOGA (1070m)	STRATA	ECOLOGY
078	*Meranoplus* sp.	x	-	1	G
079	*Monomorium* sp. 1	x	-	1	G
080	*Monomorium floricola* (Jerdon)**	x	-	2	G
081	*Monomorium* sp. 3 **	x	-	1	G
082	*Monomorium* sp. 4	-	x	1	G
083	*Myrmecina* sp. 1	-	x	1	?
084	*Myrmecina* sp. 2	-	x	1	?
085	*Myrmecina* sp. 3	-	x	1	?
086	*Myrmecina* sp. 4	x	-	1	?
087	*Myrmecina* sp. 5	-	x	1	?
088	*Oligomyrmex* sp. 1	x	-	1	G
089	*Oligomyrmex* sp. 2	x	-	1	G
090	*Oligomyrmex* sp. 3	x	-	1	G
091	*Oligomyrmex* sp. 4	x	x	1	G
092	*Oligomyrmex* sp. 5	x	-	1	G
093	*Oligomyrmex* sp. 6	-	x	1	G
094	*Pheidole (P.)* sp. 1	x	-	1	H
095	*Pheidole (P.)* sp. 2	x	x	1	H
096	*Pheidole (P.)* sp. 3	x	-	1	H
097	*Pheidole (P.) impressiceps* Mayr **	x	-	2	G
098	*Pheidole (P.)* sp. 5 **	x	-	1	H
099	*Pheidole (P.)* sp. 6	-	x	1	H
100	*Pheidole (P.)* sp. 7	-	x	1	H
101	*Pheidole (P.)* sp. 8	x	x	1	H
102	*Pheidole (P.)* sp. 9	x	-	1	H
103	*Pheidole (P.)* sp. 10	-	x	1	H
104	*Pheidole (Pheidolocanthinus)* sp. 1	x	-	1	H
105	*Pheidole (Pheidolocanthinus)* sp. 2 **	x	-	1	H
106	*Pheidole (Pheidolocanthinus)* sp. 3	x	-	1	H
107	*Pheidole (Pheidolocanthinus)* sp. 4	x	-	1	H
108	*Pheidole (Pheidolocanthinus)* sp. 5	x	-	1	H
109	*Pheidole (Pheidolocanthinus)* sp. 6	x	-	1	H
110	*Pheidole (Pheidolocanthinus)* sp. 7	x	-	1	H
111	*Pheidole (Pheidolocanthinus)* sp. *8*	-	x	1	H
112	*Pheidole (Pheidolocanthinus)* sp. *9*	-	x	1	H
113	*Pheidole (Pheidolocanthinus)* sp. 10	-	x	1	H
114	*Pheidologeton affinis* (Jerdon) **	x	-	1	G
115	*Podomyrma* n. sp 1 ** (Taylor, MS)	x	-	2	P
116	*Podomyrma* sp. 2	x	-	2	G?
117	*Pristomyrmex* n. sp. (Wang, MS)	x	-	1	G
118	*Pristomyrmex lucidus* Emery	-	x	1	G

SPECIES	SIEWA (80m)	WAPOGA (1070m)	STRATA	ECOLOGY
119 * *Pristomyrmex picteti* Emery	x	-	1	G
120 *Pristomyrmex quadridens* Emery	x	-	1	G
121 * *Pristomyrmex umbripennis* (F. Smith)	x	-	1	G
122 *Pyramica* n. sp. (Bolton, MS)	x	-	1	S
123 *Rhoptromyrmex melleus* (Emery)	-	x	1	G
124 *Rogeria stigmatica* Emery **	x	-	1	G
125 *Solenopsis papuana* Emery	-	x	1	S?
126 *Strumigenys chyzeri* Emery **	x	x	1	S
127 *Strumigenys* n. sp. Bolton MS	-	x	1	S
128 *Strumigenys* n. sp. Bolton MS	x	-	1	S
129 *Strumigenys loriai* Emery **	x	x	1	S
130 *Strumigenys mayri* Emery	x	x	1	S
131 *Strumigenys* n. sp. Bolton MS	-	x	1	S
132 *Strumigenys* n. sp. Bolton MS	x	-	1	S
133 * *Strumigenys tigris* Brown	-	x	1	S
134 *Strumigenys szalyi* Emery **	x	x	1	S
135 *Strumigenys wallacei* Emery	-	x	1	S
136 * *Strumigenys yaleopleura* Brown	x	-	1	S
137 *Tetramorium bicarinatum* (Nylander)	x	-	2	G
138 *Tetramorium fulviceps* (Emery) **	x	x	1	G
139 *Tetramorium insolens* (F. Smith)	x	-	1	G
140 *Tetramorium tricarinatum* Viehmeyer	-	x	1	G
141 *Tetramorium nr vandalum* Bolton	x	-	1	G
142 *Tetramorium* n. sp. 1	-	x	1	G
143 *Tetramorium* n. sp. 2	-	x	1	G
144 *Tetramorium* sp.	x	-	1	G
145 *Vollenhovia* sp. 1 **	x	-	2	G?
146 *Vollenhovia* sp. 2	x	-	2	G?
147 *Vollenhovia* cf. *oblonga* (F. Smith)	x	-	2	G?
148 *Vollenhovia* sp. 4	-	x	2	G?
149 *Vollenhovia* sp. 5	-	x	2	G?
PONERINAE				
150 *Anochetus cato* Forel **	x	-	1	G
151 *Anochetus variegatus* Donisthorpe	-	x	1	G
152 *Cryptopone motschulskyi* Donisthorpe **	-	x	1	G
153 *Cryptopone testacea* Emery **	x	-	1	G
154 *Cryptopone fusciceps* Emery **	x	x	1	G
155 *Diacamma rugosum* (LeGuillou) **	x	-	1	G
156 *Discothyrea* sp.	-	x	1	S?
157 * *Gnamptogenys grammodes* Brown	x	x	1	G
158 *Hypoponera biroi* (Emery)	x	-	1	G

APPENDIX 8 Ants recorded at two camps in the Wapoga area

SPECIES	SIEWA (80m)	WAPOGA (1070m)	STRATA	ECOLOGY
159 * *Hypoponera confinis* (Roger) **	x	x	1	G
160 * *Hypoponera macradelphe* (Wilson)	x	-	1	G
161 * *Hypoponera papuana* (Emery) **	x	x	1	G
162 *Hypoponera pruinosa* (Emery) **	x	x	1	G
163 *Hypoponera sabronae* (Donisthorpe)	x	x	1	G
164 *Hypoponera* cf. *sororcula* Wilson	x	-	1	G
165 *Hypoponera* sp.	-	x	1	G
166 *Leptogenys purpurea* Emery **	x	x	1	S?
167 *Leptogenys* sp. 2 *(male)*	x	-	1	?
168 *Myopias trumani* (Donisthorpe)	-	x	1	S
169 *Myopias* sp. 2	-	x	1	S
170 *Myopias* sp. 3	-	x	1	S
171 *Myopopone castanea* (F. Smith) **	x	x	1	G
172 *Odontomachus tyrannicus* F. Smith **	-	x	1, 2	G
173 *Odontomachus simillimus* F. Smith **	x	-	1, 2	G
174 *Odontomachus animosus* F. Smith	x	-	1, 2	G
175 *Odontomachus opaculus* Viehmeyer	-	x	1, 2	G
176 *Odontomachus cephalotes* F. Smith **	-	x	1, 2	G
177 *Pachycondyla* sp. 1	x	-	1, 2	G
178 *Pachycondyla* sp. 2	x	-	1, 2	G
179 *Pachycondyla croceicornis* (Emery) **	x	x	1, 2	G
180 *Pachycondyla* nr. *papuana* Viehmeyer	x	-	1, 2	G
181 *Pachycondyla* nr. *australis* (Forel)	-	x	1, 2	G
182 * *Pachycondyla striatula* Karawajew **	x	-	1, 2	G
183 *Platythyrea parallela* (F. Smith) **	x	x	1	G
184 *Platythyrea quadridentata* Donis. **	x	-	1	G
185 *Platythyrea* n. sp. *?* (*clypeata* group) x	x		1	G
186 * *Ponera alpha* Taylor **	x	x	1	G
187 * *Ponera szaboi* Emery	x	x	1	G
188 * *Ponera tenuis* (Emery)	x	x	1	G
189 *Ponera* sp. 4 *(undescr.)*	-	x	1	G
190 *Ponera* sp. 5 *(undescr.)*	x	x	1	G
191 *Ponera* sp. 6	-	x	1	G
192 *Prionopelta majuscula* Emery	x	-	1	G
193 *Prionopelta opaca* Emery **	-	x	1	G
194 *Rhytidoponera celtinodis* Wilson	-	x	1, 2	G
195 *Rhytidoponera inops* Emery **	x	-	1, 2	G
196 *Rhytidoponera* n. sp.	x	-	1, 2	G
Total samples	**106**	**117**		
Total genera	**46**	**38**		
Total species	**134**	**95**		
Total genera both sites: 51				
Total species both sites: 196				

Locations and descriptions of eighteen principle fish collecting and observation sites in the Wapoga River system, Irian Jaya, Indonesia

APPENDIX 9

Gerald Allen and Samual Renyaan

Station 1: Tirawiwa River, about 1 km from Siewa Base Camp, 3°02.665'S, 136°22.336'E; about 130 km upstream from river mouth at elevation of approximately 70 m; gravel, rock, and sand bottom; water slightly turbid to clear with minimal flow in overflow Camp channel, but moderate flow Camp in main river channel; collections made with seine in both narrow (2-3 m wide) overflow Camp channel and main river (to 10-15 m wide); average depth about 0.5 m with pools to 1.5 m deep; water temperature 30.4°C, pH 7.2; G. Allen, S. Renyaan, and B. Burnett on 3 April 1998.

Station 2: Tributary of Tirawiwa River, about 0.4 km from Siewa Base Camp, 3°02.141'S, 136°22.656'E; about 132 km upstream from river mouth at elevation of approximately 75 m; gravel, rock, and sand bottom with log snags and leaf debris; water clear, but darkly stained with slight to moderate flow Camp through nearly-closed-canopy rainforest; average width of stream about 3-4 m, depth ranging from 0.2-1.2 m; collection made with seine; water temperature 26.4°C, pH 6.2; G. Allen, and S. Renyaan on 4 April 1998.

Station 3: Braid of Tirawiwa River, about 0.7 km from Siewa Base Camp near far end of air strip, 3°02.792'S, 136°22.852'E; about 132 km upstream from river mouth at elevation of approximately 75 m; mainly gravel, cobble, bedrock, and sand bottom; collection make with 1.5 kg of rotenone at confluence of rainforest creek (clear, but dark stained, temperature 26.5, pH 6.0) and cobbled braid of Tirawiwa River (clear, temperature 30.7, pH 7.8); resulting mix flows into large rocky pool (approximately 40 m long and up to 3 m deep) with temperature 27.5 and pH 6.6; very effective rotenone collection with specimens taken up to 0.5 km downstream; open sun-exposed habitat except where shaded by trees along edge of stream; G .Allen, and S. Renyaan on 4 April 1998.

Station 4: Tributary of Tirawiwa River, about 0.4 km from Siewa Base Camp, 3°02.141'S, 136°22.656'E; same site as Station 2, except larger section (about 200 m)of stream sampled; G. Allen, S. Renyaan and B. Burnett on 5 April 1998.

Station 5: Small (approximately 12 m diameter) swampy pond on flood plain of Tirawiwa River, about 0.5 km from Siewa Base Camp on road leading to Kilometer Zero, 3°01.970'S, 136°22.231'E; about 130 km upstream from river mouth at elevation of approximately 70 m; soft mud bottom with leaf litter; water clear and still under nearly-closed-canopy rainforest; average depth about 0.3 m; collection made with seine; water temperature 27.0°C, pH 6.6; G. Allen, and S. Renyaan on 5 April 1998.

Station 6: Small tributary of Logari River, about 3-4 km from LS-21 geological exploration camp, 3°00.55'S, 136°33.13'E; about 205 km upstream from river mouth at elevation of approximately 375 m; mainly rock, cobble, and boulder bottom; water clear and slow to moderately fast flowing through nearly-closed-canopy rainforest; average width of stream about 2 m, depth ranging from 0.2-1.0 m; collection made with 0.5 kg of rotenone over 100 m section; water temperature 24.5°C, pH 6.9; G. Allen on 6 April 1998.

Station 7: Small tributary of Logari River, about 1.5-2 km from LS-21 geological exploration camp, 3°00.45'S, 136°33.23'E; about 203 km upstream from river mouth at elevation of approximately 335 m; mainly rock, boulder, gravel, and sand bottom; water clear and slow to moderately fast flowing through nearly-closed-canopy rainforest; average width of stream about 3-4m, depth ranging from 0.2-1.0 m; collection made with 1.0 kg of rotenone over 150 m section; water temperature 25.0°C, pH 7.5; G. Allen on 6 April 1998.

APPENDIX 9 Locations and descriptions of eighteen principle fish collecting and observation sites

Station 8: Tributary of Logari River next to LS-21 geological exploration camp, 3°00.35'S, 136°33.34'E; about 200 km upstream from river mouth at elevation of approximately 290 m; mainly rock, cobble, boulder, gravel, and sand bottom; water slightly turbid (due to heavy rain during previous night)and mainly fast flowing through open-canopy rainforest; average width of stream about 5-6 m, depth ranging from 0.3-1.0 m; collection made with 1.5 kg of rotenone over 150 m section; water temperature 24.0°C, pH 7.7; G. Allen on 7 April 1998.

Station 9: Logari River next to LS-21 geological exploration camp, 3°00.35'S, 136°33.34'E; about 200 km upstream from river mouth at elevation of approximately 290 m; mainly rock, cobble, boulder, gravel, and sand bottom; water clear and mainly fast flowing through open-canopy rainforest; average width of stream about 15-20 m, depth ranging 4-5 m; collection made at night with use of dipnets and flashlight at edge of main channel; water temperature 24.0°C, pH 7.8; G. Allen on 7 April 1998.

Station 10: Tributary creek of Tirawiwa River on floodplain, about 1.0 km from Siewa Base Camp on road leading to Kilometer Zero, 3°01.399'S, 136°21.892'E; about 128 km upstream from river mouth at elevation of approximately 70 m; soft mud/sand bottom with leaf litter; water exceptionally clear with very slight flow through mixed open and closed-canopy rainforest; stream width 2-5 m and average depth about 0.8m; collection made with seine; water temperature 28.7°C, pH 8.0; G. Allen, and D. Polhemus on 9 April 1998.

Station 11: Side tributary at confluence of Tirawiwa River at abandoned logging camp, about 2.0 km from Siewa Base Camp, 3°02.141'S, 136°22.656'E; about 135 km upstream from river mouth at elevation of approximately 80 m; gravel, rock, and soft sand bottom; water relatively turbid and green-colored with slow flow; open gravel bar on one side of stream and patch of rainforest on other side; collection made with 1.0 kg of rotenone over section approximately 100 m long and 15 m wide, depth to 3-4 m; water temperature 28.0°C, pH 7.2; G. Allen, and S. Renyaan on 10 April 1998.

Station 12: Side tributary at confluence of Tirawiwa River, about 4.5 km from Siewa Base Camp on road leading to Kilometer Zero (coordinates not taken); about 125 km upstream from river mouth at elevation of approximately 70 m; mainly soft mud/sand bottom with log snags; water clear, but stained with slow to moderate flow through closed-canopy rainforest; stream width 2-4 m and depths to 1.5m; collection made with 0.5 kg of rotenone over 75 m section; water temperature 26.0°C, pH 7.7; G. Allen on 12 April 1998.

Station 13: Tributary of west branch of Upper Ziwa River near Wapoga Alpha geological exploration camp, 3°08.67'S, 136°34.45'E; about 260 km upstream from river mouth at elevation of approximately 1065 m; rock, cobbles, boulder and gravel bottom; water clear with mainly fast through mixed open and closed-canopy rainforest; collection made with 1.0 kg of rotenone over section approximately 100 m long; water temperature 21.0°C, pH 8.0; S. Renyaan and S. Tenege on 12 April 1998.

Station 14: Tributary of Wapoga River about 1 km from Wapoga Staging Base Camp, 2°43.405'S, 136°06.003'E; about 10 km upstream from river mouth at elevation of approximately 10 m; mud, sand, rock, and fossil coral bottom; water clear with slow to moderate flow through mainly closed-canopy rainforest ; collection made with 1.0 kg of rotenone over section approximately 100 m long; stream width average 2-3m and average depth 0.5 m with pools to 1.5 m deep; water temperature 26.0°C, pH 8.3; G. Allen on 14 April 1998.

Station 15: Tributary of Wapoga River about 2 km downstream from Wapoga Staging Base Camp, 2°44.030'S, 136°04.886'E; about 8 km upstream from river mouth at elevation of approximately 1.0 m; soft mud bottom with log snags; water turbid with moderately fast flow through mainly closed-canopy forest (including some mangroves); collection made in pure fresh water just above level of seawater penetration in with 1.0 kg of rotenone over section approximately 200 m long; stream width average 3m and average depth 1.0 m; G. Allen on 14 April 1998.

Station 16: Tributary of Wapoga River about 4 km downstream from Wapoga Staging Base Camp, 2°42.378'S, 136°05.401'E; about 6 km upstream from river mouth at elevation of approximately 10 m; mud, sand, and limestone rock bottom; water clear with slow to relatively fast flow through second-growth vegetation; collection made with dipnets and small rubber-band propelled spear; stream width average 2-3m and average depth 0.5 m with pools to 1.5 m deep; water temperature 26.5°C, pH 8.4; S. Ansek on 14 April 1998.

Station 17: Tributary of Wapoga River about 3-4 km upstream from Wapoga Staging Base Camp, 2°45.317'S, 136°06.535'E; about 13 km upstream from river mouth at elevation of approximately 10 m; mainly mud bottom; water clear, but deeply stained with very slow flow through open-canopy rainforest; collection made with 1.0 kg of rotenone in small embayment of main channel (10 m wide and 4 m deep); water temperature 26.5°C, pH 7.3; G. Allen on 15 April 1998.

Station 18: Tributary of west branch of Upper Ziwa River near Wapoga Alpha geological exploration camp, 3°08.704'S, 136°34.439'E; about 260 km upstream from river mouth at elevation of approximately 1065 m; rock, cobbles, boulder and gravel bottom; water clear with mainly fast through mainly closed-canopy rainforest; collection made with 2.0 kg of rotenone over section approximately 100 m long; water temperature 20.0°C, pH 8.4; G. Allen on 19 April 1998.

APPENDIX 10

Annotated checklist of the fishes of the Wapoga River system, Irian Jaya, Indonesia.

Gerald Allen and Samual Renyaan

The phylogenetic sequence of the families appearing in this list follow the system that is used by the major Australian museums and approximates that proposed in Nelson's *Fishes of the World* (2nd edition, 1984, John Wiley and Sons). Genera and species are arranged alphabetically within each family.

Text for each species includes a series of annotations, each separated by a semicolon. These annotations pertain to general habitat, detailed habitat, known altitudinal range, general activity mode, social behavior, major feeding type, food items, reproductive mode, maximum size, general distributional range, and additional comments pertinent to the present survey. The length is given as standard length (SL) for most species, which is the distance from the tip of the snout to the base of the caudal fin. Total length (TL) is given for a few fishes which do not have a clearly defined caudal fin (eels and plotosid catfishes for example).

Anguillidae - Freshwater Eels

Anguilla bicolor McClelland, 1844 - Indian Short-finned Eel

Fresh water; creeks and rivers; up to at least 1000 m elev.; cryptic; solitary; carnivore; fishes, crustaceans; spawns pelagic eggs; 60 cm SL; Indo-west Pacific. Several seen during survey; probably more common than observations suggest due to its cryptic habits.

Anguilla marmorata Quoy and Gaimard, 1824 - Giant Long-Finned Eel

Fresh water; creeks and rivers; cryptic; solitary; carnivore; fishes, crustaceans; spawns pelagic eggs; at least 90 cm TL; Indo-west Pacific; on high islands from East Africa to Marquesas. Several seen during survey; probably more common than observations suggest due to its cryptic habits.

Ariidae - Forktail Catfishes

Arius velutinus (Weber, 1909) - Papillate Catfish

Fresh water; lowland creeks and rivers; diurnal benthic; solitary or in groups; omnivore; insects and higher plants; male broods eggs in mouth; 60 cm SL; Northern New Guinea; Ramu River, PNG westward to Wapoga system. Seen only near Wapoga staging, but probably common throughout alluvial floodplain habitats including rivers, creeks, and oxbow lakes.

Plotosidae - Eel-tailed Catfish

Neosilurus novaeguineae (Weber, 1908) - New Guinea Tandan

Fresh water; creeks and rivers; nocturnal benthic; solitary or in groups; carnivore; insects, crustaceans, molluscs, worms, and fishes; demersal eggs with no parental care; 21 cm SL; Northern New Guinea; Ramu River, PNG westward to Wapoga River system. Common in rainforest creeks around Siewa.

Melanotaeniidae - Rainbowfishes

Chilatherina alleni Price, 1997 - Allen's Rainbowfish

Fresh water; creeks and rivers; lowlands to at least 400 m elevation; diurnal midwater; forms aggregations; carnivore; insects, aquatic insect larvae, microcrustaceans; eggs spawned on weed or floating debris; 10 cm SL; Northern New Guinea; Derewo and Wapoga river systems of Irian Jaya. A recently described species known previously from the nearby Derewo system. The species was common throughout the survey area from lowland creeks to mountain streams. Very abundant around Siewa in both small rainforest creeks and the much larger Tirawiwa River. It exhibits an amazing range of color variation; specimens from the rainforest creek behind the Siewa Base Camp sometimes exhibit a spectacular patter involving a bright red back and yellow fins. Potentially a valuable aquarium fish.

Glossolepis leggetti Allen and Renyaan 1998 - Leggett's Rainbowfish

Fresh water; lowland creeks and rivers; to about 100 m elevation; diurnal midwater; forms aggregations; carnivore; insects, aquatic insect larvae, microcrustaceans; eggs spawned on weed or floating debris; 11 cm SL; Northern New Guinea; new species known only from the Wapoga system. A beautiful fish characterized by a overall light metallic green color with pinkish belly and diffuse blue midlateral stripe. Abundant in quiet pools of the Tirawiwa River in the vicinity of Siewa Base Camp. Also collected near the mouth of the river near Wapoga Staging Camp and therefore probably common in a variety of lowland habitats. This species was described from specimens collected on this survey and is not known from any other collections.

Melanotaenia praecox (Weber and de Beaufort, 1922) - Dwarf Rainbowfish

Fresh water; swamps and creeks; to elevation of about 100 m; diurnal midwater; forms aggregations; omnivore; insects and their larvae, crustaceans, plants; eggs spawned on weed or floating debris; 5 cm SL; Northern New Guinea; Mamberamo and Wapoga river systems of Irian Jaya. One of the surprises catches of the survey. Known previously only from a couple of sites in the Mamberamo Basin. It was collected near Siewa Base Camp from small creeks and swampy ponds. Aquarium importers heralded this neon blue species as "the fish of the century" when it first entered the trade about five years ago. Siewa specimens differ from those of the Mamberamo in having a more slender body shape and several red stripes on the body.

Melanotaenia rubripinnis Allen and Renyaan 1998 - Red-finned Rainbowfish

Fresh water; small tributaries; lowlands and foothills to at least 350 m elevation; diurnal midwater; forms aggregations; omnivore; insects and their larvae, crustaceans, plants; eggs spawned on weed or floating debris; 12 cm SL; Northern New Guinea; new species known only from the Siewa area. Common in rainforest tributaries around Siewa and mountain streams near LS-21 camp. Specimens from the small rainforest creek behind the Siewa Base Camp were remarkably patterned with bluish back, bold black midlateral stripe and bright red fins. Appears to be related to *M. vanheurni* from the Mamberamo drainage. Potentially a valuable aquarium species.

Syngnathidae - Pipefishes and Seahorses

Microphis brachyurus (Bleeker, 1853) - Short-tailed Pipefish

Fresh water; mangroves, tidal creeks, and lowland streams; below about 10 m elev.; diurnal benthic; solitary; carnivore; tiny crustaceans; male broods eggs in pouch or on ventral surface; 21 cm SL; Indo-west Pacific. A single specimen collected near Wapoga Staging Camp.

Chandidae - Glassfishes

Ambassis interruptus Bleeker, 1852 - Long-spined Glassfish

Fresh and marine waters; mangroves, tidal creeks, and lowland streams; below about 20 m elev.; hovers in midwater; forms aggregations; omnivore; insects, micro-crustaceans, fishes, algae; eggs spawned on weed or floating debris; 9 cm SL; Coastal streams of Indo-Australian Archipelago. Abundant in streams near the mouth of the Wapoga. Approximately 1000 specimens collected from a 100-metre section of 3-meter wide creek.

Ambassis macracanthus Bleeker, 1849 - Estuarine Glass Perchlet

Fresh and marine waters; mangroves, tidal creeks, and lowland streams; below about 50 m elevation; hovers in midwater; forms aggregations; omnivore; insects, micro-crustaceans, fishes, algae; eggs spawned on weed or floating debris; 10.5 cm SL; Coastal streams of Indo-Australian Archipelago; Sumatra to Irian Jaya and Papua New Guinea. Several collected in streams near the mouth of the Wapoga, also penetrating upriver nearly to Siewa Base Camp, but rare this far upstream.

Terapontidae - Grunters

Hephaestus transmontanus (Mees and Kailola, 1977) - Sepik Grunter

Fresh water; upland creeks and rivers; to at least 1500 m elevation; roving predator; solitary or in groups; carnivore; insects, crustaceans, molluscs, fishes, and frogs; demersal eggs with no parental care; 13 cm SL; Northern New Guinea; Ramu River, PNG westward to Wapoga River system. Relatively rare in our collections (about 10 taken), but we did not adequately sample the typical hillstream habitat. Wapoga specimen differ from those from other areas in having very irregular-shaped dark stripes.

Mesopristes argenteus (Cuvier, 1829) - Silver Grunter

Fresh and marine waters; mangroves, tidal creeks, and lowland streams; 0-4 m; diurnal benthic; solitary or in groups; carnivore; crustaceans, fishes; spawns pelagic eggs; 28 cm SL; Coastal streams of Indo-Australian Archipelago; Philippines, Indonesia, and New Guinea to Vanuatu. A single juvenile collected near mouth of Wapoga river.

Apogonidae - Cardinalfishes

Glossamia beauforti (Weber, 1908) - Beaufort's Mouth Almighty

Fresh water; creeks and rivers; lowlands to at least 400 m elevation; hovers in midwater; solitary; carnivore; fishes and crustaceans; male broods eggs in mouth; 16 cm SL; Northern New Guinea; Lake Sentani westward to Wapoga system. Common throughout the area. Known previously from relatively few specimens; the Wapoga represents a significant range extension.

Lutjanidae - Snappers

Lutjanus fuscescens (Valenciennes, 1830) - Papuan Spotted Bass

Fresh water; lowland creeks and rivers; to at least 100 m elevation; diurnal benthic; solitary; carnivore; fishes, crustaceans; spawns pelagic eggs; to at least 80 cm SL; Western Pacific; China, Philippines, Indonesia, and New Guinea. A single juvenile, about 20 cm SL, collected near mouth of Wapoga river.

Lutjanus goldiei (Macleay, 1884) - Papuan Black Bass

Fresh water; lowland creeks and rivers; below Camp about 80 m elev.; roving predator; solitary; carnivore; fishes, crustaceans; spawns pelagic eggs; 100 cm SL; New Guinea. Juveniles common in streams around Wapoga Staging Camp.

Toxotidae - Archerfishes

Toxotes jaculatrix (Pallas, 1767) - Banded Archerfish

Fresh and marine waters; mangroves, tidal creeks, and lowland streams; 0-2 m; surface swimmer; solitary or in groups; carnivore; floating insects; renowned for its ability to knock down insects from overhanging vegetation by spitting jets of water from its mouth; spawns pelagic eggs; 25 cm SL; Eastern Indian Ocean and western Pacific; India to Vanuatu. Common in creeks near the mouth of the Wapoga.

Scatophagidae - Scats

Scatophagus argus (Bloch, 1788) - Spotted Scat

Fresh and marine waters; mangroves, tidal creeks, and Siewa lowland streams; below Camp about 50 m elev.; forms benthic grazing schools; forms aggregations; omnivore; small benthic invertebrates, algae, and detritus; spawns pelagic eggs; 30 cm SL; Indo-west Pacific; India to Society Islands. Several observed and one collected from stream near Wapoga Staging Camp.

Mugilidae - Mullets

Cestraeus goldiei (Macleay, 1884) - Goldie River Mullet

Fresh water; creeks and rivers; penetrates mountains to at least 500 m elevation; diurnal midwater; solitary or in groups; herbivore; algae; demersal eggs with no parental care; 41 cm SL; Indo-Australian Archipelago; Eastern Indonesia to Vanuatu and New Caledonia. Has distinctive torpedo shape and is adept at penetrating well inland to an altitude of at least 350 m in fast-flowing streams; not seen in large numbers, but several individuals noted in pools at the base of rapids near LS-21 camp.

Liza subviridis (Valenciennes, 1836) - Greenback Mullet

Fresh and marine waters; lowland creeks and rivers; to at least 100 m elevation; forms benthic grazing schools; forms aggregations; omnivore; algae and organic detritus; spawns pelagic eggs; to 26 cm SL; Indo-west and central Pacific; Persian Gulf to Polynesia. One collected and several observed in sunlit pools of the Tirawiwa River near the abandoned logging camp at Siewa.

Gobiidae - Gobies

Awaous melanocephalus (Bleeker, 1849) - Largesnout Goby

Fresh water; creeks and rivers; 0-5 m; rests on bottom; solitary or in groups; omnivore; algae and small crustaceans; parental care of demersal eggs; 11 cm SL; Coastal streams of Indo-Australian Archipelago; India to New Guinea. Common in Siewa lowland streams characterized by clear water and sand-gravel bottoms. Abundant in the Tirawiwa River at Siewa.

Glossogobius bulmeri Whitley, 1959 - Bulmer's Goby

Fresh water; upland creeks and rivers; to at least 1070 m elevation; rests on bottom; solitary; carnivore; crustaceans and small fishes; parental care of demersal eggs; 10 cm SL; Northern New Guinea; Sepik River, PNG to Wapoga River system. Moderately common in the survey area. This problematical species requires further study. Specimens from the Wapoga differ from those from other areas in color pattern, having more dark botches along the middle of the side.

Glossogobius circumspectus (Macleay, 1883) - Circumspect Goby

Fresh and marine waters; mangroves, tidal creeks, and Siewa Campland streams; rests on bottom; solitary; carnivore; crustaceans and small fishes; parental care of demersal eggs; 10 cm SL; Western Pacific; Indonesia, Thailand, Philippines, and New Guinea. Common in creeks just above the level of seawater penetration at the mouth of the Wapoga.

Glossogobius koragensis Herre, 1935 - Sepik Goby

Fresh water; lowland creeks and rivers; rests on bottom; solitary; carnivore; crustaceans and small fishes; parental care of demersal eggs; 17 cm SL; Northern New Guinea; Ramu River, PNG westward to Wapoga River system. Known previously from the Ramu and Sepik systems; the Wapoga represents a significant range extension for this species. Several collected near the mouth of the river near Wapoga Staging Camp.

Periophthalmus argentilineatus (Valenciennes, 1837) - Silverstripe Mudskipper

Fresh and marine waters; mangroves, tidal creeks, and lowland streams; 0-1 m; diurnal benthic; solitary or in groups; carnivore; insects; parental care of demersal eggs; 9.3 cm SL; Indo-west Pacific; East Africa to Samoa. Abundant in creeks just above the level of seawater penetration at the mouth of the Wapoga.

Redigobius bikolanus (Herre, 1927) - Speckled Goby

Fresh and marine waters; mangroves, tidal creeks, and lowland streams; below about 50 m elev.; rests on bottom; solitary or in groups; carnivore; benthic invertebrates; parental care of demersal eggs; 3.5 cm SL; Western Pacific; Japan southward to New Guinea and Australia. Common in creeks just above the level of seawater penetration at the mouth of the Wapoga.

Schismatogobius marmoratus (Peters, 1868) - Scaleless Goby

Fresh water; lowland creeks and rivers; usually below 100 m elevation; diurnal benthic; solitary; carnivore; small invertebrates; parental care of demersal eggs; 2.5 cm SL; Western Pacific; Japan, Philippines, Indonesia, and New Guinea. Two specimens collected from rocky streambed in sunlit portion of the Tirawiwa River near Siewa Base Camp.

Sicyopterus cyanocephalus (Valenciennes, 1837) - Cleft-lipped Goby

Fresh water; lowland creeks and rivers; 0-5 m; diurnal benthic; solitary or in groups; herbivore; filamentous algae growing on rock surfaces; parental care of demersal eggs; 13 cm SL; Coastal streams of Indo-Australian Archipelago; Philippines, Indonesia, and New Guinea. The largest species of goby collected during the survey. Has specialized pelvic fin "sucker" used for clinging to the rocky substrate; uses this modification to penetrate well into the mountains to at least 1,000 m elevation. Common in moderately fast-flowing streams with rocky or cobble e bottoms.

Sicyopterus longifilis de Beaufort, 1912 - Threadfin Goby

Fresh water; creeks and rivers; diurnal benthic; solitary or in groups; herbivore; filamentous algae growing on rock surfaces; parental care of demersal eggs; 75 cm SL; Coastal streams of Indo-Australian Archipelago; Philippines, Indonesia, and New Guinea. Has specialized pelvic fin "sucker" used for clinging to the rocky substrate. Common in moderately fast-flowing streams with rocky or cobble bottoms in the vicinity of Siewa.

Sicyopterus sp. 2 - Golden Goby

Fresh water; creeks and rivers; to at least 100 m elevation; diurnal benthic; solitary or in groups; herbivore; filamentous algae growing on rock surfaces; parental care of demersal eggs; 8 cm SL; Northern New Guinea; new species known only from the Wapoga system. A striking species with long dorsal fin filaments, a golden hue on the upper half of the body, and bold black stripe along the ventralmost part of the side. Has specialized pelvic fin "sucker" used for clinging to the rocky substrate. Common in large, shallow sunlit streams with rock and cobble bottoms in the vicinity of Siewa.

Stenogobius laterisquamatus (Weber, 1908) - River Goby

Fresh water; lowland creeks and rivers; rests on bottom; solitary or in groups; herbivore; algae grazed from rocky surfaces; parental care of demersal eggs; 20 cm SL; Northern New Guinea; Ramu River, PNG westward to Wapoga River system. Apparently uncommon; only a few specimens collected from streams with sand or mud bottoms. Previously known from the Ramu and Sepik systems and a site near Jayapura; the Wapoga represents a significant range extension. Identification is provisional as specimens from the Wapoga have Siewa Camper than usual lateral-scale counts.

Stiphodon semoni Weber, 1895 - Neon Goby

Fresh water; creeks and rivers; coastal streams, but up to 120 km inland; rests on bottom; solitary or in groups; herbivore; grazes algae from rocky surfaces; parental care of demersal eggs; 3.5 cm SL; Coastal streams of Indo-Australian Archipelago; Philippines, Indonesia, and New Guinea. Apparently rare, a single specimen collected in the Siewa area.

Rhyacichthyidae - Loach Gobies

Rhyacichthys aspro (Valenciennes, 1837) - Loach Goby

Fresh water; creeks and rivers; to at least 200 m elevation; diurnal benthic; solitary; herbivore; grazes algae from rocks; parental care of demersal eggs; 25 cm SL; Western Pacific; Indonesia, Philippines, and New Guinea to Vanuatu. Rare, only two specimens collected. Has specialized pelvic "sucker", an adaptation for clinging to rocks in fast-flowing streams.

Eleotridae - Gudgeons

Belobranchus belobranchus (Valenciennes, 1837) - Throatspine Gudgeon

Fresh water; creeks and rivers; 0-5 m; rests on bottom; solitary or in groups; carnivore; fishes and small crustaceans; parental care of demersal eggs; 16 cm SL; Coastal streams of Indo-Australian Archipelago; Philippines, Indonesia, and New Guinea. Several collected from creeks near Wapoga Staging Camp. Always found close to the sea.

Butis amboinensis (Bleeker, 1853) - Ambon Gudgeon

Fresh and marine waters; mangroves, tidal creeks, and lowland streams; hovers in midwater; solitary or in groups; carnivore; insects, crustaceans, small fishes; parental care of demersal eggs; 10 cm SL; Eastern Indian Ocean and western Pacific; India to Solomon Islands. One specimen collected near Wapoga Staging Camp.

Butis butis (Hamilton, 1822) - Crimson-tipped Gudgeon

Fresh and marine waters; mangroves, tidal creeks, and lowland streams; below about 10-20 m elev.; hovers in midwater; solitary or in groups; carnivore; insects, crustaceans, small fishes; parental care of demersal eggs; 11 cm SL; Coastal streams of Indo-Australian Archipelago; Andaman Islands to New Guinea and Australia. Abundant in creeks just above the level of seawater influence near the mouth of the Wapoga.

Eleotris fusca (Bloch and Schneider, 1801) - Brown Gudgeon

Fresh and marine waters; mangroves, tidal creeks, and lowland streams; rests on bottom; solitary or in groups; carnivore; insects, crustaceans, and small fishes; parental care of demersal eggs; 15 cm SL; Indo-west Pacific; East Africa to high volcanic islands of Pacific. One specimen collected near Wapoga Staging Camp.

Eleotris melanosoma Bleeker, 1852 - Ebony Gudgeon

Fresh and marine waters; mangroves, tidal creeks, and lowland streams; below about 10-20 m elev.; rests on bottom; solitary or in groups; carnivore; insects, crustaceans, and small fishes; parental care of demersal eggs; 16 cm SL; Indo-west Pacific; East Africa to Society Islands. Common in creeks near the mouth of the Wapoga.

Hypseleotris sp. 1 - Black and White-finned Prigi

Fresh water; lowland creeks and rivers; hovers in midwater; forms aggregations; carnivore; insects and micro-crustaceans; parental care of demersal eggs; 5.5 cm SL; New Guinea; new species known from Kikori and Wapoga rivers. Several specimens collected from small creeks near the mouth of the Wapoga. This is the first record of this undescribed species from northern New Guinea; it was previously captured from southern PNG in the Kikori system.

Mogurnda nesolepis (Weber, 1908) - Yellowbelly Gudgeon

Fresh water; lowland creeks and rivers; usually below 100 m elevation; hovers in midwater; solitary; carnivore; insects, crustaceans, and small fishes; parental care of demersal eggs; 3.5 cm TL; Northern New Guinea; Markham River, PNG westward to Wapoga River system. Common in rainforest streams near Siewa. The Wapoga represents a westward range extension from the Mamberamo system.

Mogurnda sp. 1 - Wapoga Mogurnda

Fresh water; swamps and creeks; alluvial lowlands; hovers in midwater; solitary; carnivore; insects, crustaceans, and small fishes; parental care of demersal eggs; to at least 6 cm SL; Northern New Guinea; new species known only from Siewa area. Found only in overflow swamps and nearby creeks adjacent to the Kilometer Zero road near Siewa. Probably widespread in floodplain habitats. Related to *M. aurofodinae*, which is widespread in northern New Guinea.

Ophieleotris aporos (Bleeker, 1854) - Snakehead Gudgeon

Fresh water; lowland creeks and rivers; below about 400 m elev.; hovers in midwater; solitary or in groups; omnivore; algae, crustaceans, insects and their larvae; parental care of demersal eggs; 20 cm SL; Indo-west Pacific; Madagascar to islands of Melanesia and Australia. Common in lowland habitats near the mouth of the Wapoga; probably ranges throughout the floodplain in swampy areas and oxbow lakes.

Oxyeleotris fimbriata (Weber, 1908) - Fimbriate Gudgeon

Fresh water; creeks, rivers, and lakes; 10-1500 m elev.; rests on bottom; solitary; carnivore; insects, molluscs, crustaceans, and fishes; parental care of demersal eggs; 16 cm SL; New Guinea and Northern Australia. Common in forest creeks in the vicinity of Siewa and the geological exploration camp at LS-21. Most of the survey specimens are small juveniles. Adults are often difficult to collect due to their resistance to rotenone and cryptic habits. This is one of few species of true freshwater fishes found on both sides of the Central Dividing Range; it penetrates well upstream into the mountains.

Oxyeleotris gyrinoides (Bleeker, 1853) - Greenback Gauvina

Fresh water; lowland creeks and rivers; below Camp about 150 m elev.; rests on bottom; solitary; carnivore; insects, molluscs, crustaceans, and fishes; parental care of demersal eggs; 30 cm SL; Indo-west Pacific. Previously known from New Guinea only from Waigeo in Irian Jaya and the Ramu , Gogol, and Lakekamu river systems of PNG; a single subadult collected from the Siewa area in forest habitat.

Prionobutis microps (Weber, 1908) - Small-eyed Sleeper

Fresh and marine waters; mangroves, tidal creeks, and lowland streams; below about 10 m elev.; rests on bottom; solitary or in groups; carnivore; insects, crustaceans, and small fishes; parental care of demersal eggs; 18 cm SL; New Guinea and Northern Australia. A single specimen collected near mouth of the Wapoga river; often found in brackish estuaries.

Tetraodontidae - Pufferfishes

Tetraodon erythrotaenia Bleeker, 1853 - Red-striped Toadfish

Fresh and marine waters; mangroves, tidal creeks, and lowland streams; diurnal benthic; solitary or in groups; omnivore; algae, sponges, molluscs, detritus; spawns pelagic eggs; 6 cm SL; Indo-Australian Archipelago; E. Indonesia and Papua New Guinea. Extremely abundant in creeks just above the level of seawater influence near the mouth of the Wapoga.

Summary of fishes collected in the Wapoga area, Irian Jaya, Indonesia

APPENDIX 11

Gerald Allen and Samuel Renyaan

See Appendices 9 and 12 for descriptions of collecting sites.

	COLLECTING SITES																	
Genus and Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Anguilla bicolor				X								X		X				
Anguilla marmorata			X															
Arius velutinus																X		
Neosilurus novaeguineae			X	X					X			X						
Chilatherina alleni	X	X	X	X			X	X	X		X	X				X		
Glossolepis leggetti	X		X								X	X				X		
Melanotaenia praecox					X					X								
Melanotaenia rubripinnis		X	X	X		X		X	X		X							
Microphis brachyurus														X				
Ambassis interruptus														X	X			
Ambassis macracanthus												X				X		
Hephaestus transmontanus	X		X	X				X										
Mesopristes argenteus																X		
Glossamia beauforti	X		X	X			X	X			X	X						
Lutjanus fuscescens																X		
Lutjanus goldiei															X			
Toxotes jaculatrix															X			
Scatophagus argus														X		X		
Cestraeus goldiei								X										
Liza subviridis			X	X														
Awaous melanocephalus	X		X								X	X				X		
Glossogobius bulmeri			X					X	X									
Glossogobius circumspectus														X	X			
Glossogobius koragensis																X	X	
Periophalmus argentilineatus																X		
Redigobius bikolanus																X		
Schismatogobius marmoratus			X															
Sicyopterus cyanocephalus	X		X				X	X			X		X					X
Sicyopterus longifilis			X											X		X		
Sicyopterus sp.			X															
Stenogobius laterisquamatus												X						
Stiphodon semoni												X						
Rhyacichthys aspro			X															
Belanobranchus belanobranchus														X		X		
Butis amboinensis															X			
Butis butis														X	X			
Eleotris fusca																		
Eleotris melanosoma														X	X		X	
Hypseleotris sp.														X		X		
Mogurnda nesolepis.		X	X	X								X						
Mogurnda sp.					X					X		X						
Ophieleotris aporos																X		
Oxyeleotris fimbriata		X		X		X	X					X						
Oxyeleotris gyrinoides	X															X		
Prionobutis microps															X			
Tetraodon erythrotaenia															X			
Total # species	**7**	**4**	**16**	**9**	**2**	**2**	**4**	**7**	**4**	**2**	**6**	**12**	**1**	**10**	**9**	**16**	**2**	**1**

APPENDIX 12

Summary of fish collecting sites in the Wapoga River drainage, Irian Jaya, Indonesia.

Gerald Allen and Samual Renyaan

Station	Date	Locality	Approx. Distance from sea (km)	Elevation (m)	# Fish species
1	3/April/98	Tirawiwa R., Siewa Base Camp	130	70	7
2	4/April/98	forest creek, Siewa Base Camp	132	75	4
3	4/April/98	Tirawiwa R., Siewa Base Camp	132	75	15
4	5/April/98	forest creek, Siewa Base Camp	132	75	9
5	5/April/98	swampy pond, Km Zero Road	130	70	2
6	6/April/98	Logari River trib, LS-21 Camp	205	375	2
7	6/April/98	Logari River trib, LS-21 Camp	203	335	5
8	7/April/98	Logari River trib, LS-21 Camp	200	290	7
9	7/April/98	Logari River at LS-21 Camp	200	290	3
10	9/April/98	small creek, Km Zero Road	128	70	2
11	10/April/98	Logging camp, Siewa	135	80	8
12	10/April/98	trib. of Tirawiwa R., Km 0 Road	125	70	12
13	12/April/98	W. Ziwa River, Wapoga Alpha	260	1065	1
14	14/April/98	creek near Wapoga Staging	10	10	10
15	15/April/98	muddy creek, Wapoga Staging	8	1	12
16	14/April/98	creek near Wapoga Logging Co.	6	10	15
17	15/April/98	trib. upstream of Wapoga Camp	13	10	2
18	19/April/98	W. Ziwa River, Wapoga Alpha	260	1065	1

Amphibians and Reptiles recorded on the RAP survey in the Wapoga area, Irian Jaya, Indonesia

APPENDIX 13

Stephen Richards, Djoko T. Iskandar, and Allen Allison

See Introduction and Gazetteer for Locality descriptions.

SPECIES	LOCALITY			
	SIEWA (80M)	LS21 (275M)	WAPOGA (1070M)	HELIPAD 55 (1890M)
FROGS				
HYLIDAE				
Litoria angiana (Boulenger, 1915)				X
Litoria brongersmai (Loveridge, 1945)			X	
Litoria eucnemis (Lonnberg, 1900)			X	
Litoria infrafrenata (Gunther, 1867)	X			
Litoria napaea (Tyler, 1968)		X	X	
Litoria pygmaea (Meyer, 1874)	X			
Litoria thesaurensis (Peters, 1878)	X			
Litoria sp. 1	X			
Litoria sp. 2	X			
Litoria sp. 3			X	
Litoria sp. 4			X	
Litoria sp. 5			X	
Litoria sp. 6			X	
Litoria sp. 7		X	X	
Litoria sp. 8				X
Litoria sp. 9				X
Litoria sp. 10				X
Litoria sp. 11		X		
Nyctimystes fluviatilis Zweifel, 1958		X		
Nyctimystes pulcher (Wandolleck, 1910)			X	
Nyctimystes sp.1		X		
MICROHYLIDAE				
Callulops robustus (Boulenger, 1898)			X	
Hylophorbus sp.1			X	
Oreophryne sp. 1			X	
Oreophryne sp. 2			X	
Oreophryne sp. 3			X	
Oreophryne sp. 4			X	
Oreophryne sp. 5			X	
Oreophryne sp. 6				X
Oreophryne sp. 7				X
Oreophryne sp. 8				X
Oreophryne sp. 9			X	X
Oreophryne sp. 10		X		

SPECIES	LOCALITY			
	SIEWA (80M)	LS21 (275M)	WAPOGA (1070M)	HELIPAD 55 (1890M)
Sphenophryne macrorhyncha (van Kampen, 1906)			X	
Sphenophryne sp. 1			X	
Xenorhina oxycephala (Schlegel, 1858)		X		
Xenorhina sp. 1			X	
Xenorhina sp. 2			X	
MYOBATRACHIDAE				
Lechriodus platyceps Parker, 1940				X
RANIDAE				
Limnonectes grunniens (Sonnini and Latreille, 1801)		X		
Platymantis papuensis Meyer, 1874	X	X	X	
Platymantis sp. 1	X			
Rana daemeli (Steindachner, 1868)	X			
Rana jimiensis Tyler, 1963			X	
Rana supragrisea Menzies, 1987		X	X	
Rana sp. 1	X			
Rana sp. 2			X	
Total = 47 species				
REPTILES				
TURTLES				
Elseya novaeguinea (Meyer, 1874)	X			
LIZARDS				
SCINCIDAE				
Emoia caeruleocauda (de Vis, 1892)	X			
Emoia irianensis Brown, 1991			X	X
Emoia jamur Brown, 1991	X			
Emoia jakati (Kopstein, 1926)	X			
Emoia klossi (Boulenger, 1914)				
Emoia longicauda (Macleay, 1877)		X		
Emoia sp. 1 (nr *paniai*)			X	
Emoia sp. 2			X	
Papuascincus stanleyanus (Boulenger, 1897)				X
Sphenomorphus stickeli (Loveridge, 1948)		X	X	
GEKKONIDAE				
Cyrtodactylus mimikanus (Boulenger, 1914)	X			
Cyrtodactylus sp. 1			X	
Hemidactylus frenatus (Dumeril and Bibron, 1836)	X			

SPECIES	LOCALITY			
	SIEWA (80M)	LS21 (275M)	WAPOGA (1070M)	HELIPAD 55 (1890M)
AGAMIDAE				
Hypsilurus "*auritus*" (Meyer, 1874)			X	
Hypsilurus modestus (Meyer, 1874)		X		
SNAKES				
BOIDAE				
Candoia aspera (Gunther, 1877)		X		
ELAPIDAE				
Acanthophis antarcticus (Shaw, 1794)	X			
Aspidomorphus muelleri (Schlegel, 1837)		X		
Toxicocalamus stanleyanus Boulenger 1903		X		
COLUBRIDAE				
Boiga irregularis (Merrem 1802)	X			
Tropidonophis elongatus (Jan, 1865)		X		
Tropidonophis mcdowelli Malnate and Underwood, 1988			X	
Tropidonophis multiscutellatus (Brongersma, 1948)			X	
Tropidonophis novaeguineae (van Lidth de Jeude, 1911)	X			
Total = 25 species	**18**	**17**	**33**	**11**
Grand Total = 72 Species				

APPENDIX 14

Species accounts of frogs collected on the RAP survey in the Wapoga area, Irian Jaya, Indonesia

Stephen Richards, Djoko T. Iskandar and Allen Allison

HYLIDAE

Litoria angiana (Boulenger, 1915)
Montane forests; riparian, torrential streams; arboreal; nocturnal; carnivore, prey preferences unknown. Large, long-legged frog with polymorphic colour pattern. SVL 66 mm (males), 80 mm (females);. Widespread in mountains of New Guinea from Vogelkop Peninsula to eastern Papua New Guinea. At Helipad 55 several individuals were found perched on low branches near a torrential stream.

Litoria brongersmai (Loveridge, 1945)
Forests; riparian, torrential streams; arboreal, nocturnal; prey preferences unknown. A small species, SVL 23-24.5 mm (males). Previously known only from one collection near Doorman Top, where it was collected in 1922. This record represents a westerly range extension of 220 km. At Wapoga males called from leaves over small torrential streams. Call a long series of cricket-like chirps.

Litoria eucnemis (Lonnberg, 1900)
Forests; arboreal; riparian and swamps; nocturnal; carnivore, prey preferences unknown. Mottled brown and green, distinct crenulated ridge along outside of arm and leg; SVL to about 70mm. Widespread in lowlands and hills of New Guinea, isolated populations on Cape York Peninsula, northern Queensland. At Wapoga a male was calling from leaves over a small, slow-flowing stream.

Litoria infrafrenata (Günther, 1867)
Forests, savanna, gardens, human habitation; riparian, swamps; arboreal; nocturnal; carnivore, prey preferences unknown. Large, slender green to brown frog with distinct white stripe on lower lip. SVL to 135mm. Widespread in lowland New Guinea, eastern Indonesia and northern Queensland, Australia. At Siewa many individuals were calling at night from ditches and swamps around the exploration camp. Call a loud double note repeated regularly for long periods.

Litoria napaea (Tyler, 1968)
Forest; riparian, torrential streams; arboreal, nocturnal; prey preferences unknown. Pale brown with variable dark markings dorsally. A small species, SVL 24 mm (males), 28 mm (females). A series of specimens from Wapoga and LS21 is tentatively assigned to this species. Previously known only from the type locality, Idenberg River in the Snow Mountains, where it was collected by the Third Archbold Expedition in 1939. This record is a westerly range extension of nearly 300 km. At Wapoga males called from leaves over torrential streams. Three different call types are produced.

Litoria pygmaea (Meyer, 1874)
Forest; swamps; arboreal; nocturnal; carnivore, prey preferences unknown. Slender, brown frog with variable pale markings dorsally. SVL to 45mm. K nown from widely scattered localities in western and southern New Guinea. At Siewa two males were calling from low vegetation in a swamp behind the exploration camp. Call a loud, high pitched bleating sound in which each note appears to have about 3-4 distinct pulses.

Litoria thesaurensis (Peters 1878)
Wide range of habitats; arboreal, nocturnal. Prey preferences unknown. Color extremely variable, bones green, juveniles with three bright yellow dorsal stripes, connected between eyes. Moderate size, SVL 50 mm (males), 65 mm (females). Widespread across lowlands of New Guinea, from Vogelkop in west to Admiralty Archipelago and Solomon Islands in east. At Siewa a single juvenile found on leaf over swamp behind exploration camp.

Litoria sp. 1
A small (males 30 mm), undescribed green treefrog related to *Litoria gracilenta* but distinguished from that species by its distinctive mating call. Common in swamps adjacent to Siewa exploration camp. Call with two notes “waaaa-waa”. A second population recently discovered near Nabire by Dr Rainer Gunther. Currently being described by R. Gunther and S. Richards.

Litoria sp. 2
A small, SVL 26-30 mm (males), 32.5 mm (females), undescribed frog related to Litoria *bicolor* but distinguished from that species by its much larger size, and distinct advertisement call. Common in swamps around Siewa exploration camp. Two different calls - 1) a short, distinctly pulsed note and 2) a long "zeeeeep".

Litoria sp. 3
A moderate sized species (SVL males 37.5-47.0 mm, females 53 mm). Morphologically indistinguishable from frogs of the *Litoria arfakiana* group but having different call(s) from all recognized taxa within that group. A torrent-dwelling species with extremely variable coloration. At Wapoga found on low vegetation (1-2m high) next to torrential streams. It is possible that more than one species is included in our series. Specimens from Wapoga produced three different calls, and we did not observe the same frog producing more than one call type. Given the morphological similarity of all specimens, and the possibility that different calls were due to social interactions, we have chosen to regard our specimens as a single taxon until further data are available.

The discovery of this species raises several taxonomic issues. Two of the three currently recognised species in the *arfakiana* group (*Litoria arfakiana* and *L. wollastoni*) were both described from Irian Jaya (Arfak Mountains and Lorentz region respectively). However the most recent diagnoses of these species were based largely on the call structure of material from Papua New Guinea (Menzies and Zweifel 1974). It is possible that the Wapoga taxon represents either true *arfakiana* or *wollastoni* (or both) and that these names have been erroneously applied to PNG taxa. Menzies and Zweifel (1974) correctly suggest that advertisement calls of *Litoria arfakiana* and *L. wollastoni* at the type localities are required to address this issue.

Litoria sp. 4
A small (males 30-33 mm), undescribed green treefrog with pale yellow spots dorsally. At Wapoga males called from ferns over a small, slow-flowing muddy stream. Call a single, distinctly pulsed note. Currently being described by S. Richards and D. Iskandar.

Litoria sp. 5
A small (SVL males 25-30 mm, a female 29.8 mm) undescribed treefrog with a distinctly tubercular dorsum and extensively webbed fingers. An exceptionally aquatic species, found along torrential streams at Wapoga. Two specimens were collected during the day in nets set for fish. The remainder were found on leaves over streams at night. A second population of this species was recently discovered near Nabire by Dr Rainer Gunther.

Litoria sp. 6
A small (males 25-27.5 mm) undescribed treefrog with large eyes and reduced toe webbing. At Wapoga found on low vegetation adjacent to torrential streams. Call a short, quiet rattle. Currently being described by S. Richards and D. Iskandar.

Litoria sp. 7
A moderately large (males 43-46 mm) undescribed treefrog with numerous large, conical tubercles on the dorsum and limbs. Males called at night from leaves over torrential streams at Wapoga and LS21. Call a series of loud and explosive notes that are produced more rapidly and are more distinctly pulsed towards the end of each call series. Currently being described by S. Richards.

Litoria sp. 8
A small (males 28-29 mm), undescribed dark brown treefrog found on low vegetation along a steep montane torrent at Helipad 55.

Litoria sp. 9
A small (males 30-33 mm, a female 54.1 mm) undescribed brown treefrog found among boulders and on low vegetation along a steep montane torrent at Helipad 55.

Litoria sp. 10
A small (males 29-32 mm) undescribed treefrog with a sharply pointed snout and small spike on each heel. Males called from low vegetation adjacent to a steep, montane torrent at Helipad 55. Currently being described by S. Richards and D. Iskandar.

Litoria sp. 11.
A small (male 34.8 mm) undescribed species of uncertain affinities. Known only from LS21. Resembles members of the *Litoria arfakiana* group but lacks the sharply-pointed snout typical of this group.

Nyctimystes fluviatilis Zweifel, 1958
Forest; riparian, small streams; arboreal, nocturnal; carnivore, prey preferences unknown. Pale grey dorsally. SVL 39.5 mm (a male) 50 mm (a female). Palpebral venation (reticulum on eyelid) in the form of thick, vertically oriented lines with few horizontal connections. Previously known only from the type specimen which was collected at the Idenburg River, Snow Mountains, during the Third Archbold Expedition in 1939. The specimen from LS21 represents a westerly range extension of about 300 km.

Nyctimystes pulcher (Wandolleck, 1911)
Montane forest; riparian, torrential streams; nocturnal; Carnivore, prey preferences unknown. Brown, slender, large spike on heel. Eyes large, palpebral venation brown, lines aligned predominantly vertical - oblique. SVL 65 mm (males), 80 mm (females). Widespread in the mountains of New Guinea. At Wapoga males perched on low vegetation over torrential streams.

Nyctimystes sp. 1
A moderate sized (SVL 56.0 mm) undescribed species from LS21. Brown dorsally with contrasting pale spots. Venter red in life. Palpebral venation in the form of thick, vertically oriented lines with few horizontal connections.

MICROHYLIDAE

Callulops robustus (Boulenger, 1898)
Forest; fossorial (burrow-dwelling); carnivore, prey preferences unknown. Dark brown, short-legged frog. SVL 75 mm. Widespread in New Guinea from Vogelkop Peninsula to islands off south-east coast of PNG; lowlands and mountains to 2000m. Call "a series of five to seven very loud, harsh, croaking notes" (Zweifel, 1972). At Wapoga a single juvenile was collected from a burrow in the forest floor. Males were calling from burrows at the base of dense vegetation adjacent to the helipad during and after heavy afternoon rain.

Hylophorbus sp.
Forest; terrestrial, litter; nocturnal; carnivore, prey preferences unknown. Slender, brown frog with black markings laterally. SVL 31.5 mm. Morphologically similar to *H. rufescens*, which is a complex of species. The Wapoga specimen had a call unlike that of *H. rufescens* elsewhere in New Guinea.

Oreophryne species
Ten species of *Oreophryne* were recorded during the RAP. Most if not all of the taxa collected are undescribed, but the taxonomy of this genus is chaotic due mainly to the species' conservative morphology and lack of data on call structure. *Oreophryne* species are not treated separately here, with the exception of the following three morphologically distinct species.

Oreophryne sp. 3
A sharp-snouted species with black face and throat and variable dorsal coloration. SVL 21-23.5 mm. At Wapoga males called from leaves about 1 meter above the ground at night after rain. Specimens possibly representing this undescribed species were collected recently in the Wondiwoi Mountains by Dr R. Guenther.

Oreophryne sp. 7
A very large *Oreophryne*, a single male measuring 40.2 mm. Pale grey dorsally with large finger and toe discs. Common at Helipad 55 but extremely difficult to collect because males called from > 6 m above the ground in *Pandanus* trees covered with long sharp spines. The call is a single mournful "hoot"

Oreophryne sp. 8
A tiny species, male SVL 9.2-11.5 mm. Pale brown dorsally, some specimens with two black dorsal stripes. Found only in a rocky gully at Helipad 55 where frogs called from deep within thick moss clumps on large boulders and low branches. Probably Irian Jaya's smallest terrestrial vertebrate. Currently being described by S. Richards and D. Iskandar.

Sphenophryne macrorhyncha (van Kampen, 1906)
Forest; streams; semi-aquatic, diurnal, nocturnal; carnivore, prey preferences unknown. Pale grey, mottled with darker brown; toes extensively webbed, eyes dorsal. SVL 40mm. Recorded from several localities in the foothills and mountains of Irian Jaya. Most specimens previously referred to this species probably represent the undescribed species listed below (R.G. Zweifel, pers. comm). Call a long series of harsh yapping notes.

Sphenophryne sp. 1
An undescribed semi-aquatic species that is morphologically similar to *S. macrorhyncha*. It can be distinguished from that species by its more uniform grey dorsal coloration, and its mating call, which is a very long series (sometimes exceeding 200 notes) of rasping notes. Widespread in the hills and mountains of New Guinea. At Wapoga males called at night and during the day, from on or beneath rocks in and adjacent to waterfalls and torrential streams.

Xenorhina oxycephala (Schlegel, 1858)
Forests, gardens, regrowth; fossorial, nocturnal; carnivore, earthworms (Zweifel, 1960). SVL 47 mm. Brown with narrow vertebral stripe. Snout narrow, eyes small. Widespread in the lowlands of northern New Guinea, from the Vogelkop Peninsula and Yapen Island in the west to the Adelbert Mountains in the east. Call a series of "five to ten unpulsed notes in deceleration " produced in series of "between three and five calls" (Price 1994). A single specimen collected at night from beneath leaf litter at edge of helipad clearing, LS21.

Xenorhina sp. 1
A moderately large species, SVL 40.5 mm. An unusual undescribed *Xenorhina* with greatly expanded finger and toe discs. Arboreal, at Wapoga one specimen was collected from a small *Pandanus* tree, and other specimens, presumably representing this species, were heard calling from high in large *Pandanus* adjacent to the camp. This is the first record of arboreal habits for this predominantly fossorial and terrestrial genus.

Xenorhina sp. 2
A moderate-sized undescribed *Xenorhina* with expanded toe pads and variable dorsal coloration. Snout narrow, eyes small. Fossorial, at Wapoga two calling males were collected from beneath litter on the forest floor. Calling occurred at night only during and immediately after heavy rain.

MYOBATRACHIDAE

Lechriodus platyceps Parker, 1940
Forest, litter; terrestrial, nocturnal; carnivore, prey preferences unknown. Pale grey with black markings. Head broad, elongate dorsal and dorso-lateral skin folds. Male with large nuptial spines on fingers, female with wide flanges on first and second fingers. Large species, SVL 95 mm. Widespread in montane forests of western New Guinea. At Helipad 55 two specimens were found on the forest floor where they were exceptionally well camouflaged against the litter.

RANIDAE

Limnonectes grunniens (Daudin, 1801)
Forest; swamps, semi-aquatic; nocturnal; carnivore, spiders, terrestrial insects (Menzies 1987). Mottled brown, shallow groove between eyes, eyes dorsal, toes fully webbed. SVL 140 mm. A widespread species occurring from Halmahera and Ambon to the Fly and Sepik river systems of Papua New Guinea. A single juvenile collected at LS21.

Platymantis papuensis Meyer, 1874
Forest; terrestrial; nocturnal; carnivore, prey preferences unknown. Back with numerous short skin folds, toes without webbing, colour highly variable. SVL 46 mm (males), 64 mm (females). Widespread and abundant in lowlands and foothills of northern New Guinea. At Wapoga and Siewa males called from the litter or slightly elevated perches from dusk in forest and regrowth around the camps. Call a series of rather musical quacking notes.

Platymantis sp. 1
An undescribed species found in sympatry with *P. papuensis* at Siewa. Morphologically similar to, but smaller than, *P. papuensis*. Call a rapid "trill", distinct from *P. papuensis* and all other *Platymantis* species. At Siewa males called from the base of dense regrowth around the camp during late afternoon until after dark. A second population was discovered recently near Nabire by Dr R. Gunther. Currently being described by R. Gunther.

Rana jimiensis Tyler, 1963
Forests; terrestrial, riparian, medium to large rivers; nocturnal; carnivorous; brown, with very warty skin; toes fully webbed; very large frog with small tympanum; heavy bodied with long powerful rear legs; SVL to about 120mm. Our collection represents a significant westerly range extension of about 500 kms, and the first record of this species from Irian Jaya.

Rana daemeli (Steindachner, 1868)
Wet to dry forests; terrestrial; savanna and grasslands; riparian and still water, small to large streams and rivers, pools, swamps; carnivorous, prey preferences unknown; Sharp-snouted frog with long, powerful and distinctly banded rear legs; SVL to about 80mm. Widespread in New Guinea and northern Queensland, Australia. Males call from banks adjacent to water or from emergent logs. Eggs laid in floating mass (Menzies, 1987) and tadpole benthic (Richards 1992), probably detritivore. At Siewa males were calling at night from swamps in forest adjacent to the camp.

Rana supragrisea Menzies, 1987
Hill forest; terrestrial; riparian, nocturnal; carnivorous, prey preferences unknown; sharp-snouted, long-legged frog; brown, males turn yellow during reproduction. A large species, SVL to 85 mm (males), 105 mm (females). Widespread in New Guinea from Vogelkop Peninsula to southeastern Papua New Guinea. Adults were observed at night on elevated perches adjacent to small and medium streams. Call 2-3 squeaky notes uttered in rapid succession.

Rana sp. 1
A moderately large, undescribed species of the *Rana papua* group. SVL 57 mm (males), 81 mm (females). Snout pointed, legs long, powerful. Distinguished from other members of this group by its call, a series of four notes uttered from elevated sites adjacent to swamps. Common in forest at Siewa camp.

Rana sp. 2
An undescribed species of the *Rana papua* group. Three sub-adult frogs were collected from a small swamp at Wapoga camp. Distinguished from all other species in this group by the presence of a distinct cream-colored lateral stripe extending from the snout, below the eye, to the groin.

List of birds recorded on the RAP survey in the Wapoga area, Irian Jaya, Indonesia

APPENDIX 15

Andrew L. Mack, Wahyu Widodo, and Boeadi

See Introduction and Gazetteer for site descriptions.

Sighting categories:
A- abundant (more than ten sightings)
C- common (5-10 sightings)
U- uncommon (3-5 sightings)
R- rare (1-2 sightings)

	SITE			
TAXA	**HELIPAD 55 (1890 m)**	**WAPOGA A (1070m)**	**LOGARI (LS 21) (275m)**	**SIEWA (80m)**
Casuarius unappendiculatus			R	R
Casuarius bennetti	R	U		
Talegalla jobiensis			R	R
Phalacrocorax melanoleucos				R
Phalacrocorax sulcirostris				R
Egretta alba				R
Egretta intermedia				R
Nycticorax caledonicus				U
Zonerodius heliosylus		R		
Tadorna radjah				U
Dendrocygna arcuata				R
Accipiter poliocephalus			R	
Henicopernis longicauda		U		U
Aviceda subcristata				C
Haliastur indus				C
Elanus caeruleus				R
Aquila gurneyi				R
Hieraaetus morphnoides	R	U	R	
Falco berigora				R
Charadrius dubius				C
Tringa hypoleucos			R	C
Henicophaps albifrons				R
Gallicolumba beccarii	R			
Otidiphaps nobilis		R	R	
Goura victoria				U
Macropygia amboinensis			C	A
Macropygia nigrirostris	C	C	R	R
Reinwardtoena reinwardtsi	C	C	A	
Ptilinopus pulchellus				U
Ptilinopus rivoli	R	U		
Ptilinopus coronulatus				A
Ptilinopus magnificus			C	C
Ptilinopus iozonus				U
Ptilinopus superbus				R
Ptilinopus naina				R
Ptilinopus perlatus				R

APPENDIX 15 List of birds recorded on the RAP survey

	SITE			
TAXA	**HELIPAD 55 (1890 m)**	**WAPOGA A (1070m)**	**LOGARI (LS 21) (275m)**	**SIEWA (80m)**
Ptilinopus ornatus				U
Ducula pinon			A	A
Ducula zoeae			R	R
Ducula chalconota	U			
Ducula rufigaster			R	
Charmosyna papou	C			
Charmosyna josefinae		R		R
Charmosyna rubronotata			C	
Charmosyna pulchella		R		
Lorius lory		C	A	A
Pseudeos fuscata				U
Oreopsittacus arfaki	A			
Neopsittacus musschenbroekii	A	C		
Trichoglossus haematodus			C	A
Eclectus roratus			R	C
Alisterus chloropterus		R		
Chalcopsitta duivenbodei				A
Geoffroyus geoffroyi			C	A
Geoffroyus simplex	R			
Psittrichas fulgidus		R	C	U
Cacatua galerita		U	C	A
Probosciger aterrimus				A
Micropsitta bruijnii	A			
Micropsitta pusio				R
Cyclopsitta diophthalma				R
Psittaculirostris salvadorii			U	
Psittacella brehmii	U			
Psittacella modesta	R			
Chrysococcyx meyeri		R		U
Chrysococcyx ruficollis	U			
Chrysococcyx minutillus				R
Cuculus saturatus				R
Centropus menbeki			R	R
Centropus phasianinus				R
Scythrops novaehollandiae		U	C	C
Eudynamis scolopacea				R
Cacomantis variolosus	A	A	A	A
Cacomantis castaneiventris	A	C		
Cacomantis flabelliformis	R			
Ceyx lepidus			A	U
Alcedo azurea			C	C

	SITE			
TAXA	**HELIPAD 55 (1890 m)**	**WAPOGA A (1070m)**	**LOGARI (LS 21) (275m)**	**SIEWA (80m)**
Dacelo gaudichaud				A
Merops ornatus				A
Eurystomus orientalis				C
Rhyticeros plicatus	R	U	A	A
Tyto tenebricosa	R	R		
Collocalia esculenta	A	A	A	A
Collocalia vanikorensis			A	A
Collocalia hirundinacea	A	C		
Hirundapus caudacutus	U			
Hemiprocne mystacalis		R		
Artamus leucorynchus				U
Ptilorrhoa caerulescens			R	
Ptilorrhoa castanonota		R		
Coracina caeruleogrisea		R	U	
Coracina papuensis				C
Coracina longicauda	U			
Coracina schisticeps				U
Coracina boyeri			C	C
Coracina montana	A	A		
Coracina morio			U	U
Coracina melas			C	U
Campochaera sloetii			C	C
Lalage atrovirens			R	U
Malurus cyanocephalus				C
Malurus alboscapulatus				U
Clytomyias insignis	U			
Gerygone palpebrosa		U		
Gerygone chloronotus	C	C		
Gerygone chrysogaster			A	A
Phylloscopus trivirgatus	C	C		
Crateroscelis murina		C	C	C
Crateroscelis nigrorufa	C	R		
Crateroscelis robusta	R			
Sericornis virgatus		R		
Sericornis nouhuysi	A			
Sericornis papuensis	U	U		
Sericornis arfakianus		U		
Sericornis spilodera		R	C	
Sericornis beccarii		A		
Rhipidura hyperythra		U	C	
Rhipidura atra	C	C		

APPENDIX 15 List of birds recorded on the RAP survey

	SITE			
TAXA	**HELIPAD 55 (1890 m)**	**WAPOGA A (1070m)**	**LOGARI (LS 21) (275m)**	**SIEWA (80m)**
Rhipidura threnothorax			R	
Rhipidura rufidorsa			U	
Rhipidura albolimbata	A	U		
Rhipidura leucophrys				U
Arses telescophthalmus			A	A
Monarcha guttulus			C	C
Monarcha chrysomela			R	R
Monarcha axillaris	C	A		
Monarcha rubiensis			U	
Monarcha manadensis			U	
Monarcha frater			R	
Peltops montanus	C	A		
Monachella muelleriana		C	C	
Drymodes superciliaris		U		
Amalocichla incerta	C			
Peneothello cyanus	A			
Poecilodryas brachyura			U	
Pachycephalopsis hattamensis		A		
Tregallasia leucops	R	A		
Microeca papuana	A			
Microeca flavovirescens		U		
Microeca griseoceps		U		
Machaerirhynchus flaviventer				U
Machaerirhynchus nigripectus	C			
Eugerygone rubra	U			
Motacilla cinerea		R		
Pachycare flavogrisea		A		
Pachycephala soror	U	U		
Pachycephala schlegelii	A			
Pachycephala hyperythra		A		
Rhagologus leucostigma		R		
Androphobus viridis	U			
Eulacestoma nigropectus	U			
Ifrita kowaldi	U			
Colluricincla megarhyncha		U	A	A
Pitohui ferrugineus		U	A	A
Pitohui dichrous		A	U	
Pitohui cristatus		R	R	
Pitohui kirhocephalus		R	U	C
Dicaeum pectorale		R	C	A
Oreocharis arfaki	A			

	SITE			
TAXA	**HELIPAD 55 (1890 m)**	**WAPOGA A (1070m)**	**LOGARI (LS 21) (275m)**	**SIEWA (80m)**
Melanocharis nigra			C	C
Melanocharis versteri		C		
Melanocharis longicauda		R		
Zosterops fuscicapillus	A	C		
Daphoenositta chrysoptera	R			
Cormobates placens	R			
Ptiloprora perstriata	R			
Nectarinia aspasia			C	A
Toxorhamphus novaeguineae		U	A	C
Toxorhamphus poliopterus	C	A		
Oedistoma iliolophus		C	C	C
Oedistoma pygmaeum		R	C	
Myzomela rosenbergii		A		
Myzomela cruentata		R		
Myzomela nigrita		R		
Timeliopsis griseigula				R
Meliphaga orientalis	R	U		
Meliphaga aruensis		C	C	A
Meliphaga montana		C		
Lichenostomus obscurus		U	C	
Xanthotis flaviventer			C	A
Melipotes fumigatus	A			
Melidectes belfordi	A	R		
Melidectes torquatus		U		
Melidectes ochromelas		R		
Melilestes megarhynchus		C	C	C
Pycnopygius stictocephalus				U
Pycnopygius ixoides			R	
Philemon brassi			A	C
Philemon meyeri				R
Philemon buceroides			C	A
Erythrura trichroa		R		
Oriolus szalayi			R	R
Mino dumontii			U	A
Ailuroedus buccoides			U	
Ailuroedus melanotis		R		
Pomatostomus isidorei				U
Amblyornis macgregoriae	R			
Archboldia papuensis	R			
Paradisaea minor			C	U
Ptiloris magnificus			R	R

APPENDIX 15 List of birds recorded on the RAP survey

	SITE			
TAXA	**HELIPAD 55 (1890 m)**	**WAPOGA A (1070m)**	**LOGARI (LS 21) (275m)**	**SIEWA (80m)**
Astrapia splendidissima	U			
Cicinnurus regius			C	C
Cicinnurus magnificus	U	C	C	
Lophorina superba	R	R		
Dicrurus bracteatus		R	C	A
Chaetorhynchus papuensis		A	U	
Paradigalla brevicauda	U			
Grallina bruijni	U	U		
Cracticus cassicus			U	C
Cracticus quoyi			C	A
Corvus orru				R
Corvus tristis		R	C	U

Noteworthy bird species observed on the RAP survey in the Wapoga area, Irian Jaya, Indonesia

APPENDIX 16

Andrew L. Mack, Wahyu Widodo, and Boeadi

Psittaculirostris salvadorii

Psittaculirostris salvadorii is a small parrot confined to the lowlands of the eastern side of Geelvink Bay and northern Irian with records as far east as the Cyclops Mountains. It is one of the poorest-known birds of Irian Jaya, known only from a handful of specimens. Unfortunately, our observations were not sufficient to add much to our knowledge: although fig parrots were seen several times, only one perched individual at Logari was seen well enough for a certain identification. Fig parrots seen in flight at Siewa might have been this species as well.

The Salvadori's Fig-Parrot is listed as vulnerable on the Red List (IUCN 1996) due to its restricted range. Because the range of this species includes many logging concessions and transmigration encampments a vulnerable status is clearly justified. This parrot is not considered protected under Indonesian law and international pet trade is allowed. Reliable data on trade is not readily available from within Indonesia and many irregularities occur in reported data (Nash 1992, 1994). Data from CITES permits of Salvadori's Fig-Parrots being imported into 45 recipient countries suggest trade is increasing. There are permits for 70 birds in 1985, 123 in 1986, 33 in 1987, 473 in 1986, and 365 in 1991. Clearly more data and better data are needed in order to assess the true impact of the pet trade on this and other parrot species. Members of the RAP team that passed through Timika at different times saw evidence of parrot trade by soldiers stationed in Timika. Uniformed soldiers brusquely discouraged us from approaching barracks and containers by the airport from which we could hear many parrots calling. Although it is unlikely soldiers in Timika would have this species, it is clear that some soldiers are involved in parrot trade. We recommend that better data be collected on the parrot trade in Irian Jaya and that ecological assessments be made of the remaining habitat and requirements of *Psittaculirostris salvadorii.*

Philemon brassi

The Brass's Friarbird is one of the poorest-known species in all of New Guinea and is rated as Data Deficient by the IUCN (1996). It was discovered in 1939 on the Archbold Expedition at the Bernhard Camp in an area of dense second growth on the Idenburg River at 50 m elevation (Rand 1940). Since then it has not been collected. At Wapoga I saw friarbirds that were suspicious looking, but did not see them well enough to positively eliminate Meyer's Friarbird (*Philemon meyeri*). At Lagori I saw more of these friarbirds often very well and was convinced it must be this species *(fide* M. Moore). We found one feeding low in a flowering *Elaeocarpus* sp. tree overhanging the river, not more than 15 meters from us in excellent light. Birds did not display the white markings around the face as conspicuously as indicated by the plate in Beehler et al. (1986); these markings were only conspicuous at close range. However, the pale chin, overall paler coloration, and slim build are visible from a greater distance and distinguish this species from *P. meyeri.* By working the forest along the edge of the Tirawiwa River at base camp we saw at least two more individuals of this species. It is astounding that this record is roughly 250 km away from the one site where the bird was previously-known. Very little ornithological work has been done in the region between Bernhard Camp and Logari, so it is easy to see how it could have been overlooked. Quite possibly the bird is fairly common in the Rouffaer drainage (Logari was just over a low divide from the upper Rouffaer).

Where the Archbold Expedition found it, it was common. Rand and Gilliard (1968) reported the birds at Bernhard camp were found in cane brakes and secondary forest around one of the lagoons. Although all the birds we saw were near the rivers' edges and disturbed areas, none were low or in cane brakes. Along the Tirawiwa River birds perched in trees above the canes, but we never saw them descend to the canes. We suspect the observations in canes by Rand and Gilliard is more anomalous than typical. Birds we observed behaved more like typical friarbirds, taking nectar, mixing with other nectarivorous birds at flowering trees. They were not highly vocal or pugnacious like *Philemon novaeguineae*; the only vocalization We heard was a typical *Philemon* upslurred call note.

Androphobus viridis

The Papuan Whipbird is another little-known species, seen by few ornithologists and listed as Data Deficient by the IUCN (1996). Described in 1911 from specimens from Mt Goliath, it is also known from the Weyland Mountains and the Lake Habbema/Ibele River area and presumably points between these two sites. Several unconfirmed sight records have been made in PNG (Collar et al. 1994). Two were observed at the high camp, Helipad 55. Both birds, seen on different days, were in the lower canopy to mid-story, neither vocalized and both seemed shy.

Archboldia papuensis

Archbold's Bowerbird was first discovered and described in 1940 from the Lake Habbema area. Since then it has been discovered at a few scattered localities through the highlands from the Weyland Mountains to Mt. Giluwe and Mt. Hagen in PNG, but nowhere is it particularly common. The easternmost populations (*sanfordi)* are sometimes considered distinct. At Helipad 55 a female was observed once closely before it noticed me and flew away.

Mammals recorded on the RAP survey in the Wapoga area, Irian Jaya, Indonesia.

APPENDIX 17

Boeadi and Wahyu Widodo

See Introduction or Gazetteer for descriptions of sites.

Species with asterix (*) marker were only seen and not collected.
f = female
m = male

	SITE			
SPECIES	**Siewa (80 m)**	**Wapoga (1070 m)**	**Heli Pad 55 (1890 m)**	**Total # species**
CHIROPTERA (BATS)				
Macroglossus minimus	--	9 (6f, 3m)	--	9
Syconycteris australis	2 (1f, 1m)	--	5 (2f, 3m)	7
Syconycteris hobbit	--	--	3 (3f)	3
Paranyctimene raptor	5 (3f, 2m)	--	--	5
Rousettus amplexicaudatus	2 (1f, 1m)	--	--	2
Pteropus sp.*	Seen	Seen	--	--
Rhinolophus euryotis	--	1 (1f)	--	1
RODENTIA (MURIDAE)				
Rattus praetor	--	3 (2f, 1m)	--	3
Stenomys niobe	--	--	2 (1f, 1m)	2
Melomys rubex	--	20 (10f, 10m)	--	20
Marsupialia (Dasyuridae)				
*Myoictis melas**	--	Seen	Seen	--
T O T A L	9	33	10	62