The morphological variability of the Polish carmine scale, *Porphyrophora polonica* (L.) (Coccinea, Margarodidae)

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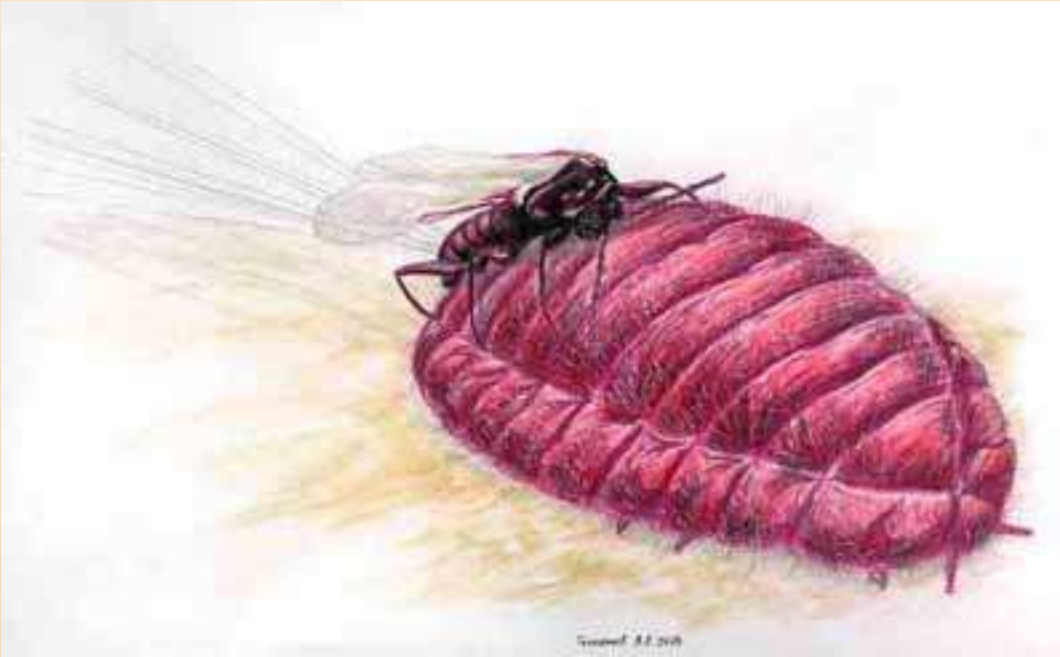
Systematic position of **Polish carmine scale**

INSECTA

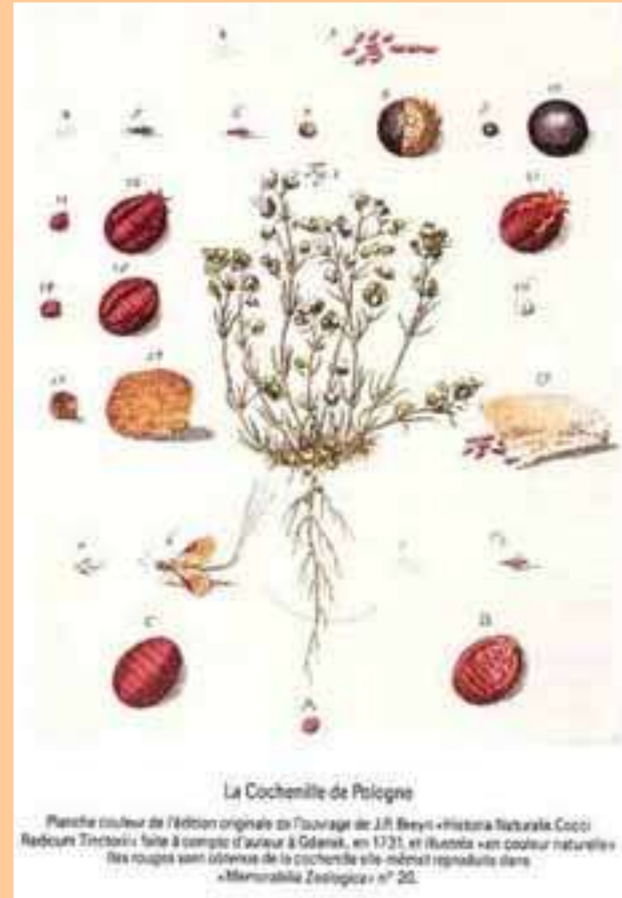
- Order **Homoptera**
- Suborder **Coccinea**
- Family **Margarodidae**
- Subfamily **Margarodinae**
- Tribe **Margarodini**
- Genus ***Porphyrophora***
- Species ***polonica* (L), 1758**



Picture by V.Timokhanov

Photos by I.Foldi from Kozstarab, Kozar, 1985

Ancient map of collecting sites
for *Porhorophora polonica* (L.)



First published pictures
of *Porphyrophora polonica* (L.)
by J.P. Breyn (1731)

Some textile tissues colored by carmine; it was produced from *Porphyrophora* insects:
A – XI century in Spain, B – ancient Iranian carmine; background – ancient carmine tissue
(by Dominique Cardon (1990))

Distribution of *Poprhyrophora polonica* (L.)

The Polish carmine scale (*Porphyrophora polonica*) inhabits the steppe and forest-steppe zones of Eurasia, from Central Europe to Eastern Mongolia, and it also penetrates through steppe biotopes of North and West Tien-Shan to the Hissar Ridge in Tajikistan. The wide distribution and polyphagy of *P. polonica* allows us to assess morphological variability within *P. polonica*, and compare it to its close relative, *P. ussuriensis*. Because external morphology of females is of prime importance, females from different populations throughout the species range were examined. Patterns in morphological diversity allowed us to predict the form of populations of *P. polonica* thought to be present in West China (Xinjang), and to assess similarity between some populations of *P. polonica* and *P. ussuriensis*.

According to our research Polish carmine scale lives on more than 60 host-plants from 20 genera 15 families in European part of distribution (there are not Fabaceae and Rubiaceae). In Kazakhstan it lives on 13 species from 9 genera 5 families (Caryophyllaceae, Rosaceae, Fabaceae, Asteraceae, and Rubiaceae). In Mongolia - 5 species of the genus Caragana (Fabaceae) and Cleistogenes squ-arosa (Poaceae).

The common host-plants:

for Europe and Kazakhstan - ***Dianthus***, ***Fragaria***, ***Potentilla*** as well as representatives of **Caryophyllaceae**, **Rosaceae** and **Asteraceae**.

for Kazakhstan and Mongolia – representatives of **Fabaceae**

for Mongolia and Europe – representatives of **Poaceae**

The composition of host-plants in Europe is richer than in eastern part of distribution.

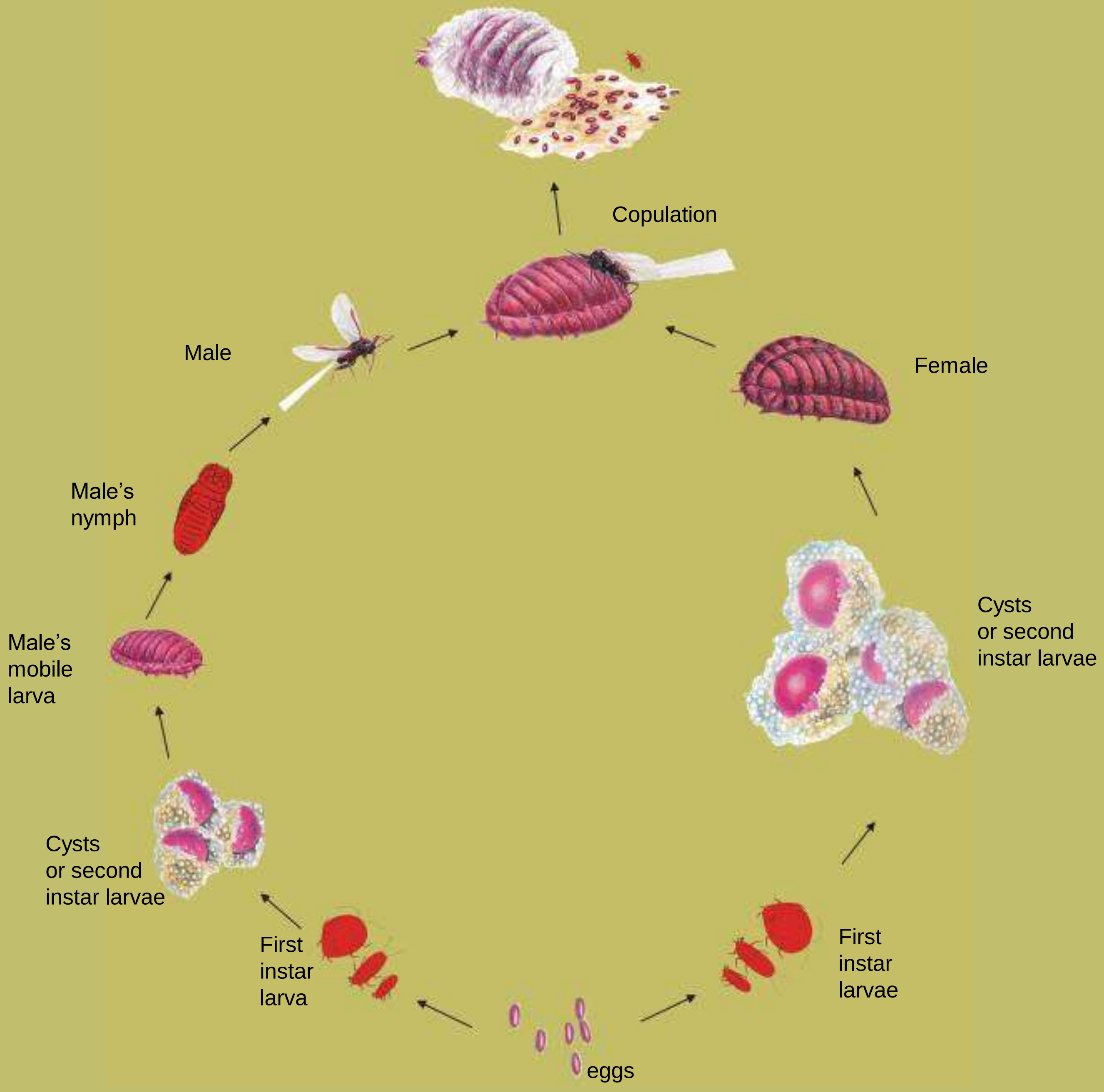
Potentilla bifurca
in Dzhungarian Alatau Mts.
(Kazakhstan)

The list of determined host-plants of *Porphyrophora polonica* (L.)

Spergularia campestris, S.sp.,
Herniaria glabra,
Scleranthus perennis, S. annus,
Cerastium semidecanorum,
C. dentatum,
Myosoton aquaticum,
Melandryum album,
Silene wolgensis,
Dianthus sp.,
Gypsophila sp.,
Potentilla erecta, P. argentea,
P. anserina, P. bifurca, P. recta,
P. conferta, P. orientalis,
Fragaria vesca, Fragaria sp.,
Siballdianthe adpressa,
Astragalus sp.,

Caragana microphylla, C. bungei, C. pygmeae,
C. leucophloea,
Festuca valesiaca,
Secale sp.,
Cleistogenes squarosa,
Seseli annuum,
Pimpinella sp.,
Galatella haupti,
Hieracium pilosella,
Origanum vulgare,
Polygonum alpinum,
Melampyrum sp.,
Galium ruthenicum,
Alkanna tinctoria,
Arctostaphylos uva-ursi,
Parietaria sp.,

Female of *Porphyrophora polonica*



Life circle of *Porphyrophora* species
(pictures by V.Timokhanov & R. Jashenko)

The wide distribution and polyphagy of *P. polonica* allows us to assess morphological variability within *P. polonica*, and compare it to its close relative, *P. ussuriensis*.

Because of external morphology of females is of prime importance, females from different populations throughout the species range were examined.

Patterns in morphological diversity allowed us to predict the form of populations of *P. polonica* thought to be present in West China (Xianjiang), and to assess similarity between some populations of *P. polonica* and *P. ussuriensis*.

Distribution of *P. polonica* and *P. ussuriensis*

A total of **298 females** were studied from **29 populations** in the forest-steppe and steppe biotopes from

Poland,
Ukraine,
Kazakhstan,
Russia (southeastern Siberia, Tuva),
Mongolia

as well as steppe biotopes, slopes and mountains of

Altai,
Saur,
Tarbagatay,
Dzhungarian Alatau,
Terskey Alatau
Hissar .

Region	#	Region and collecting site	Host-plants
		Poland	
POLAND	1	Warsaw Province, Skolimov, 17-27.June.1906 (A.Mordvilko)	*Scleranthus sp.*
	2	Polska,okolice Kolisza,Pomorskiego, 16.07.1965 (H.Werner)	unknown
		Ukraine	
UKRAINE	3	Kherson area, Big Alexandrovka Aug.1929 (A.Kirichenko)	*Dianthus sp.*
	4	Belgorod, 21-24.August.1985 (A.Prisniy)	unknown
	5	Donetsk area, Svyatogorsk,5.July.1962, (E.Tereznikova).	*Potentilla impolita*
		West Siberia	
	6	Baraba steppe,1961 (I. Stebaev)	unknown
		Kazakhstan:	
ALTAI	7	Kalbinskiy Rdg., Tavricheskoe Vlg., dry steppe, 27.July.1961 (G.Matesova)	*Potentilla bifurca*
	8	Slopes Kalbinskiy Rdg., Leninka Vlg., steppe, 1.July.1961 (G.Matesova)	*Potentilla recta*
	9	Kalbinskiy Rdg., Shebundy Vlg., 19.July.1961, steppe, (G.Matesova)	*Potentilla bifurca*
	10	Azutau Rdg., 20 km N-E Alekseevka, h=1300 m, steppe, 24. July.1986 (R.Jashenko)	*Potentilla bifurca*
SAUR	11	Slopes Saur Rdg., Zaisan Town, steppe, 1.July. 1962 (G.Matesova)	*Potentilla bifurca*
	12	Saur Rdg, Przhevalskoe, Kenderlik River-bed, 21.July.1986 (R.Jashenko)	*Potentilla bifurca*
	13	Saur Rdg., 20 km S. Zaisan, steppe slope, h-1100 m, 18.July.1986 (R.Jashenko)	*Potentilla bifurca*
EAST KAZAKH TABLE LAND	14	30 km W. Ayaguz, steppe, 21.July.1986 (R.Jashenko)	*Potentilla bifurca*
	15	Semipalatinsk City, 9 km S Big Vladimirovka, pinus forest in river-bed, 5.July.1978 (G.Matesova)	*Melandryum album*
TARBAGATAY		North slopes of Tarbagatay Rdg.	
North slopes:	16	31 km S. Kyzylkesek, dry steppe, 9.July.1986 (R.Jashenko)	*Potentilla bifurca*
	17	40 km S. Tarbagatay Vlg., steppe site among subalpine meadow, h-1800 m, 5.July.1986 (R. Jashenko)	*Potentilla bifurca*
	18	40 km S. Tarbagatay Vlg., stony dry steppe site, h-1300 m, 5.July.1986 (R.Jashenko)	*Potentilla bifurca*
South slopes:		South slopes of Tarbagatay Rdg.:	
	19	33 km E.Tarbagatay, steppe, 8.July.1986 (R.Jashenko)	*Gallium ruthenicum*
	20	Blagodarnoe Vlg., Keldemurat river-bed, steppe, h-900m, 6.August.1986 (R.Jashenko)	*Potentilla bifurca*
DZHUNGARIAN ALATAU	21	North slopes of Dzhungarian Alatau Mts., Topolevka, steppe, h-1000m, 27.July.1985 (R.Jashenko)	*Potentilla bifurca*
	22	Koyandytau Rdg., 10 km E. Araltobe, steppe, 13.July.1985 (R.Jashenko)	*Potentilla bifurca*
	23	South slopes of Dzhungarian Alatau Mts., 6 km NN-E. Sarybel, steppe, 9.July.1987 (R.Jashenko)	*Potentilla bifurca*
		Central Tien-Shan	
	24	South slopes of Terskey Alatau Rdg., Sary-Zhas Valley, h-2900 m, 20.July.1989 (I. Kabak)	*Potentilla sp.*
		South Kazakhstan	
TALASSKIY ALATAU Mts.	25	Kuyuk Pass, 11.July.1958 (G.Matesova)	*Dianthus sp.*
	26	N-W slopes of Aksay Valley, 28.June.1966 (G.Matesova)	*Dianthus sp.*
		Tajikistan	
TAJIKISTAN	27	Hissar Rdg., Ziddy Vlg., 18-20.July.1944 (N.Borchsenius)	*Medicago sp.*
		Tuva	
TUVA	28	Sayany, Agar Rdg., Urzin, steppe above the Tes-Khem river-bed, 21.July.1961 (D.Berman)	unknown
		Mongolia	
MONGOLIA	29	South coast Kerulen River, Tumentsogt, 7. August. 1982, (Ulykpan)	*Caragana microphilla*

Eighteen females of *P. ussuriensis* from **Buryatia** (Russia), **Mongolia** **Russian Far East** were studied.

Estimation of morphological similarity was done according to indices of intrapopulation diversity, frequency of the rare morphs, and similarity among populations,

as suggested by Zhivotovskiy (1981).

#.	Collecting site	Host-plants
Russian Far east, Primrskiy Kray:		
1.	Mikhaylovskiy district, Grigorievka Vlg., 1.Sept.1939 (Suleymanov, Shutova). LECTOTYPE and 6 PARALECTOTYPES	*Potentilla sp.*
2.	Ussuriysk City, 18.July.1961 (V. Tryapitsyn)	Fabaceae
3.	Vladivistok City, Shamora Bay, 29.June.1937 (A. Kirichenko), and 10.July.1963 (E.Danzig)	*Potentilla sp.*
Buryatia:		
4.	Tunkin Valley, 30 km E. Arshan, 30.July.1970 (E.Danzig)	*Potentilla bifurca*
Mongolia:		
5.	East-Gobi Aimak, 30 km E-SE Dzavsar-Bulak, 25.July.1971 (I.Kerzhner)	*Potentilla acaulis*
6.	Sukhote-Batyr Aimak, Tumentsogt, 25.July.1983 (Ulykpan)	*Koeleria cristata*

For analysis, specimens were compared from 7 geographic areas:

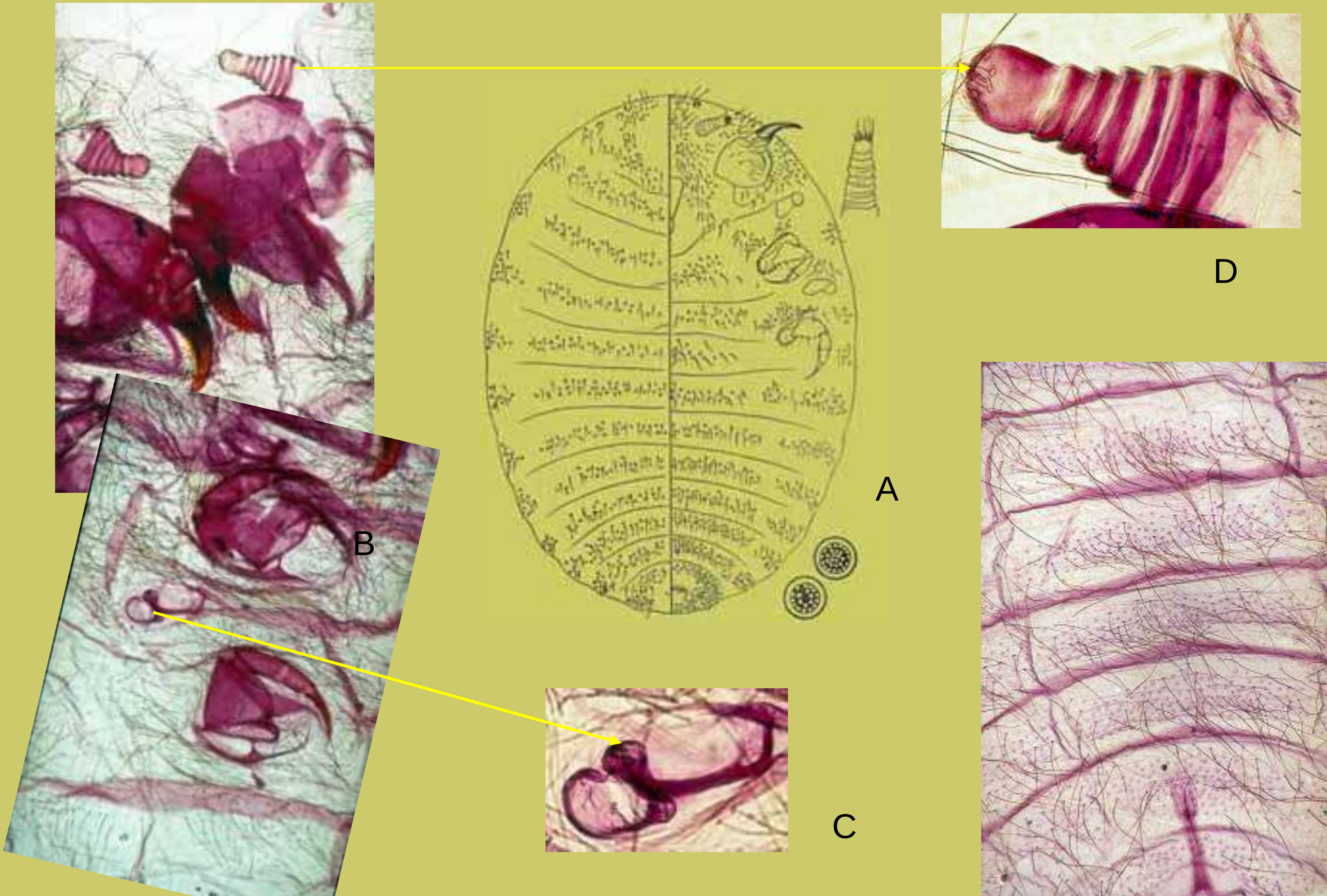
Poland,
Ukraine,
Altai,
Saur,
East Kazakh Table Land,
Tarbagatay,
Dzhungarian.

Similarly, specimens were compared from three different hosts:

Dianthus from Ukraine and South Kazakhstan,
Potentilla from Ukraine and Kazakhstan,
Potentilla bifurca from Kazakhstan.

Eighteen females of *P. ussuriensis* from Buryatia (Russia), Mongolia and Russian Far East were studied. Estimation of morphological similarity was done according to indices of intrapopulation diversity, frequency of the rare morphs, and similarity among populations, as suggested by Zhivotovskiy (1981).

Potentilla bifurca with
P. polonica cyst on the ruts.



Morphology of *P. polonica* (female): A – scheme picture, used in publication;
B,C,D,E – photo of microscopic slides, Tuva population (env. Urzin Town);
B- antennae, legs and thoracic spiracle; C - thoracic spiracle; D – left antenna;
E- abdominal sternites

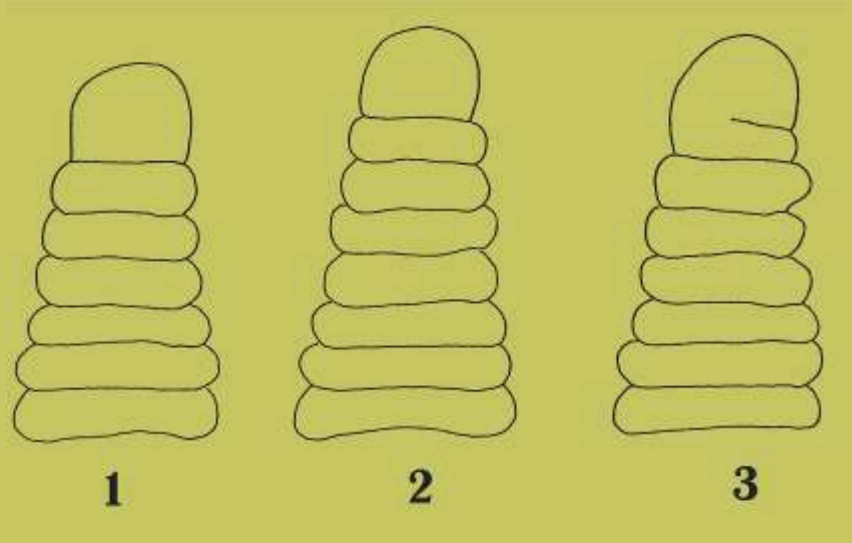
A total of 15 morphological characters were analyzed:

Character I – number of antenna segments, 3 morphs:

1) 7-segmented,

2) 8-segmented,

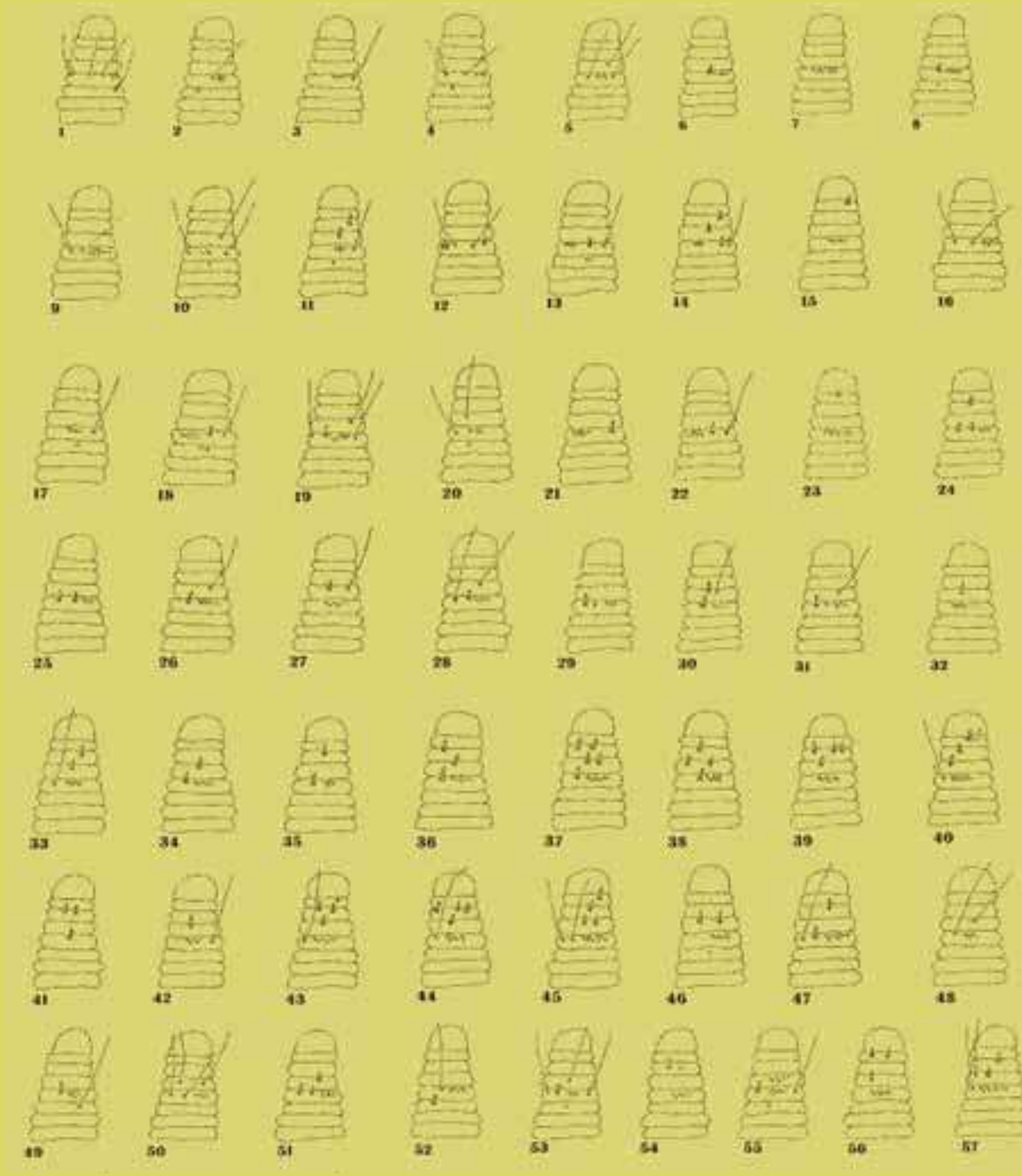
3) 7th and 8th segments are joined on half.

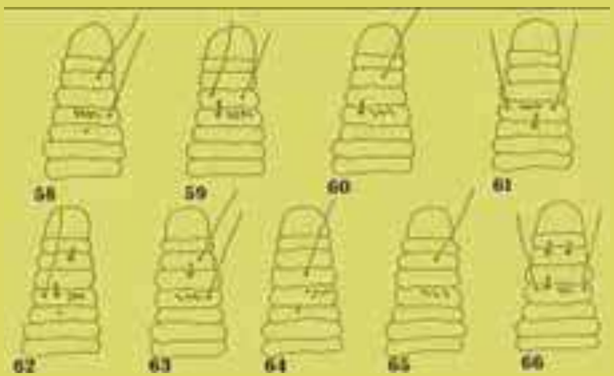


Character II –

number of long, short, sensor setae and pores on II-VI (VII) segments of antenna,

observed 66 morphs.





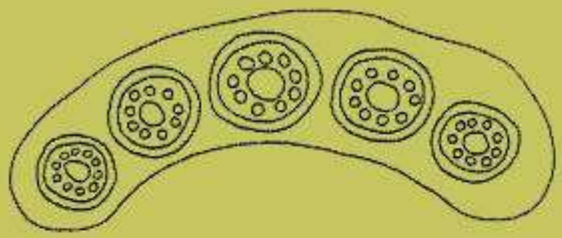
Character III –
number of sensor setae
on apical segments of antenna;
12 morphs:
1) 5 setae,
2) 6 setae,
3) 7 setae,
4) 8 setae,
5) 9 setae,
6) 10 setae,
7) 11 setae,
8) 12 setae,
9) 13 setae,
10) 14 setae,
11) 15 setae,
12) 16 setae.

Character IV –
number of long setae
on apical segment of antenna,
8 morphs:
1) 3 setae,
2) 4 setae,
3) 5 setae,
4) 6 setae,
5) 7 setae,
6) 8 setae,
7) 9 setae,
8) 10 setae.

Character V –
number of multilocular pores
in one thoracic spiracle,
9 morphs:
1) 2 pores,
2) 3 pores,
3) 4 pores,
4) 5 pores,
5) 6 pores,
6) 7 pores,
7) 8 pores,
8) 9 pores,
9) 10 pores,
each thoracic spiracle
was analyzed separately.

Character VI –
number of pores near
thoracic spiracles,
8 morphs:
1)1 pore,
2) 2 pores,
3) 3 pores,
4) 4 pores,
5) 5 pores,
6) 6 pores,
7) 7 pores,
8) 8 pores.

Character VII –
structure of multilocular pores
in thoracic spiracles;
(all pores with 1 central locula)
3 morphs:
1) with 1 circle of peripheral loculae,
2) with 1 circle of loculae in one
and 2 circles of peripheral loculae
in other pore,
3) with 2 circles of peripheral loculae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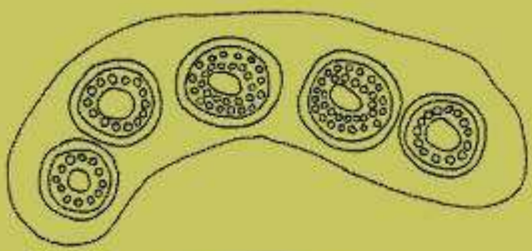
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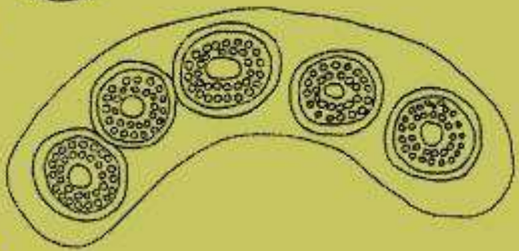
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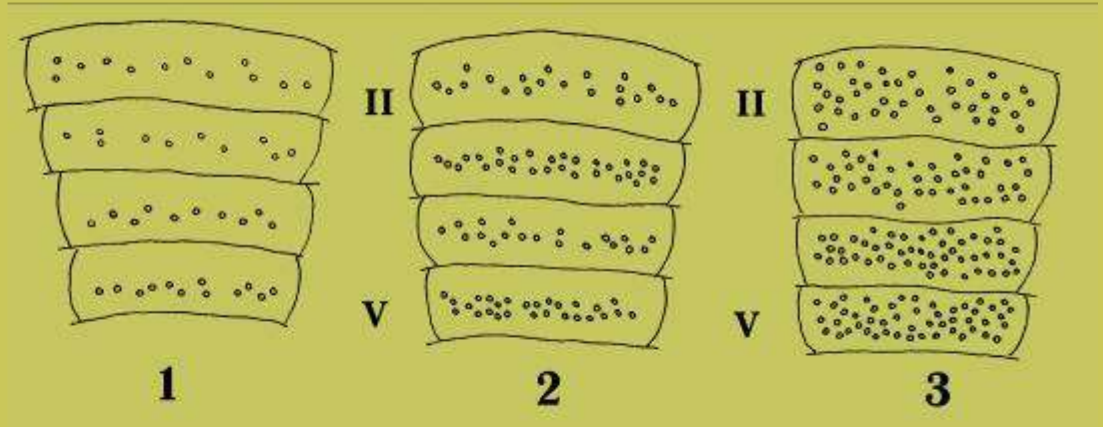
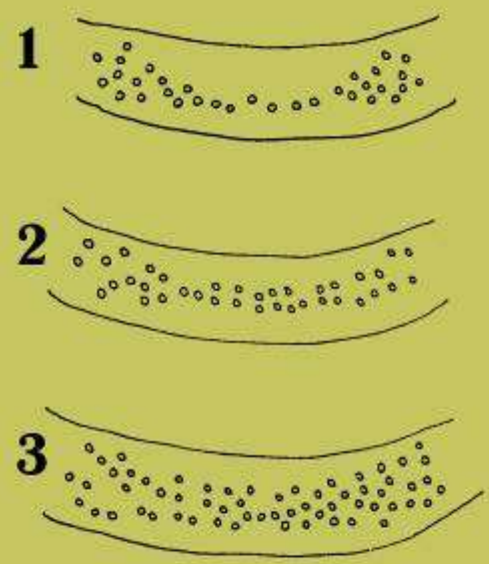
Character VIII –
location of multilocular pores
in central part of II-V abdominal sternits,
3 morphs:
1) 1-2 rows of pores,
2) narrow belt of pores,
3) wide belt of pores.

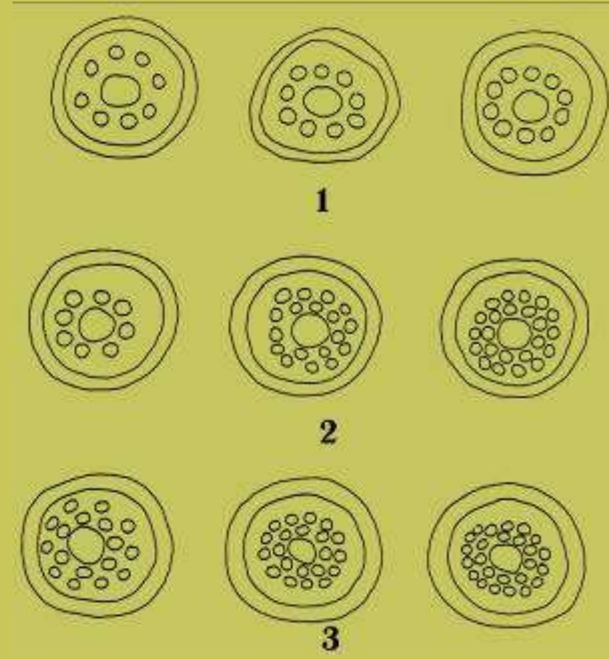


Character IX –
location of multilocular pores
in central part of VII abdominal sternits,
3 morphs:
1) 1 row,
2) narrow belt,
3) wide belt .



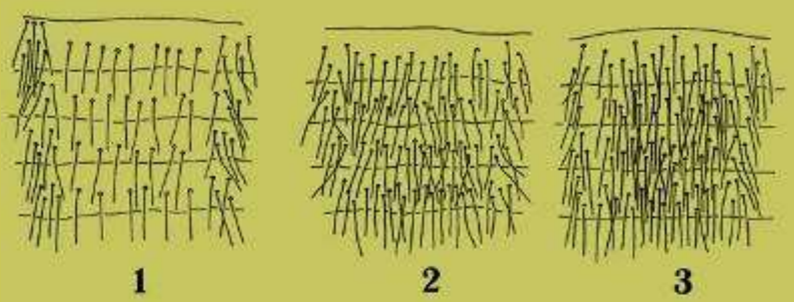
Character X –
location of multilocular pores
in central part of II-V abdominal
 tergits, 3 morphs:
1) 1 row,
2) narrow belt,
3) wide belt

Character XI –
structure of multilocular pores on I-VI abdominal segments;
all multilocular pores with central locula, 3 morphs:
1) with 1 circle of loculae,
2) with 1, 1.5 and 2 circles of loculae,
3) with 2 circles of loculae
(see picture in the right)



Character XII –
structure of multilocular pores on VII-VIII abdominal segments (in general), all multilocular pores with central locula, 4 morphs
1) with 1, 1.5 and 2 circles of loculae,
2) with 1.5, 2 and 3 circles of loculae,
3) with 2 circles of loculae,
4) with 2-3 circles of loculae

Character XIII –
location of long setae in central part of II-V abdominal sternits,
3 morphs:
1) 1 row of setae,
2) narrow belt,
3) wide belt of setae. **(see picture in the right)**



Character XIV –
location of long setae in central part of II-V abdominal tergits;
3 morphs: 1) 1-2 rows of setae, 2) narrow belt of setae, 3) wide belt.

Character XV –
location of long setae in central part of VII abdominal tergits, 3 morphs: 1) 1-2 row of setae, 2) narrow belt of setae, 3) wide belt of setae.

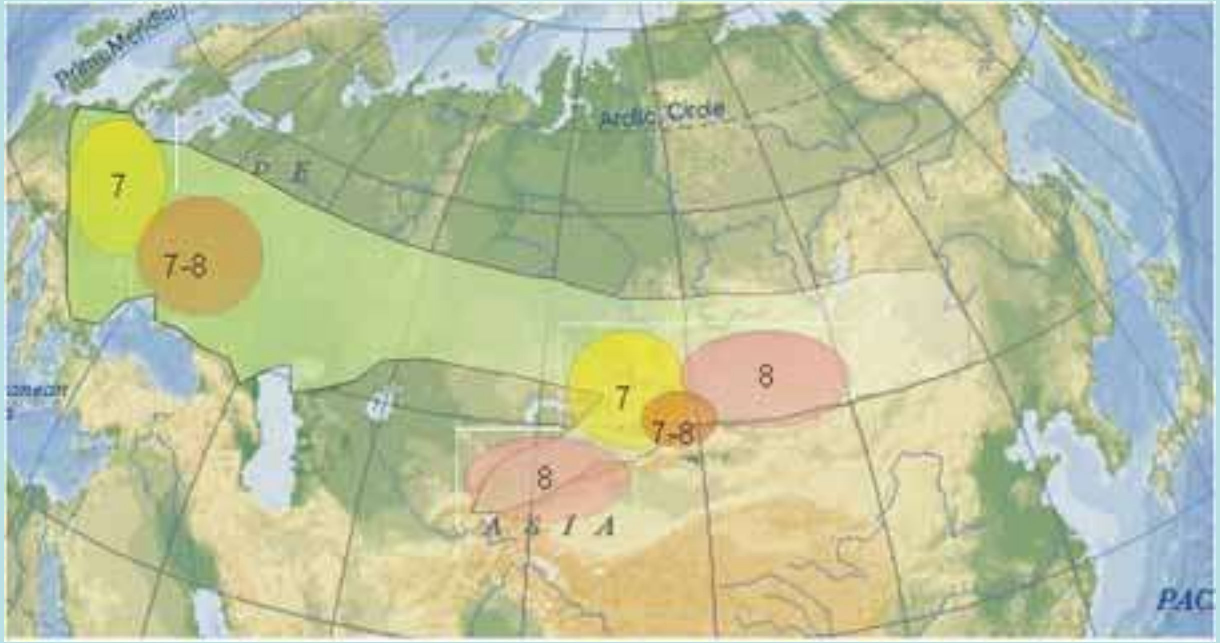
Character I - number of antenna segments

Distribution of morphs showed their correlation between 7-segmented antennae and the host-plant *Potentilla*

Unknown host-plants for populations from env. Belgorod City (south Russia) and env. Urzin Town (Tuva, Russia) most probably is *Potentilla* because of predominance of 7-segmented antennae.

All distribution area of *P. polonica* can be divided on some regions with

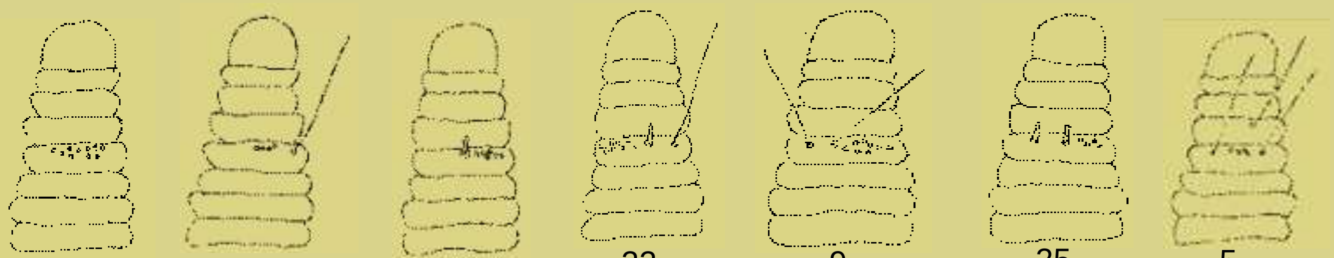
7-segmented antennae (Poland, Altai, Saur, Dzhungarian Alatau),
8-segmented (south Kazakhstan, Tajikistan, Mongolia) antennae
7-8-segmented antennae region (Ukraine, Tarbagatay).



Character II – number of long, short, sensor setae and pores on II-VI (VII) segments of antenna

Total 66 morphs.
Dominated morphs. There are 7 dominated morphs (72.9 %) :

7th - 32.1%;
3rd - 17.5%;
6th - 11 %;
22nd - 3.6 %;
9th - 3.3 %;
25th - 2.9 %;
5th - 2.5 %.



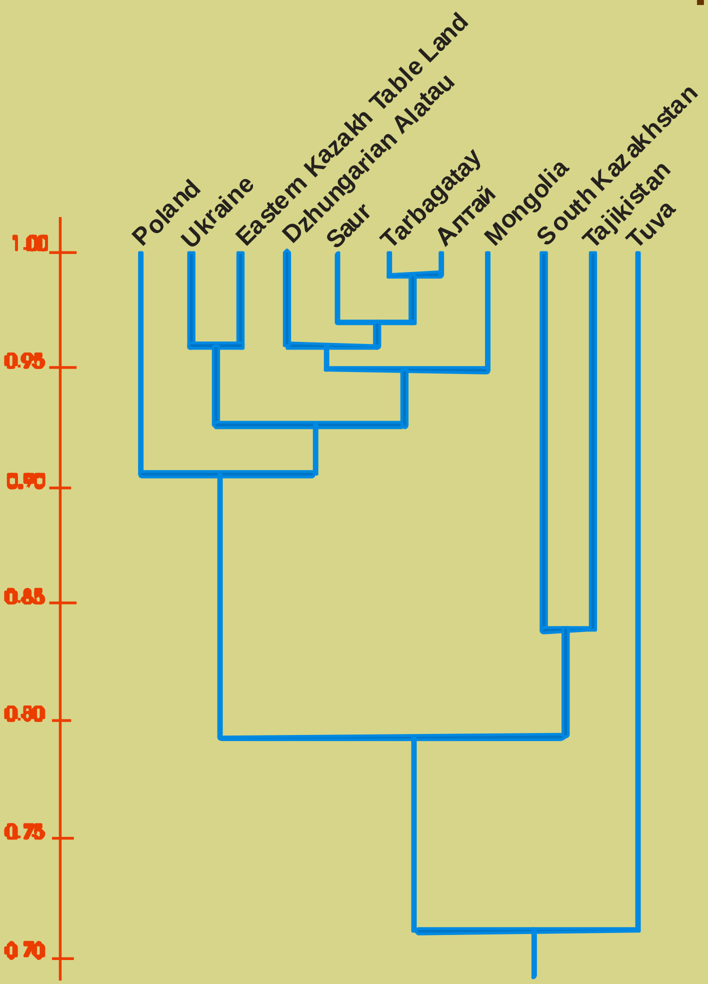
The evolution of coccids is going, mainly, to morphological simplification and specialization of structures. The evolution of antennae of *P. polonica* is going to reducing of the number of segments, setae and pores. The most frequent 7th morph has the most simple structure, the next frequent 3rd morph has the more compound structure, 6th - more compound and so on. This pattern is shown on the Table below.

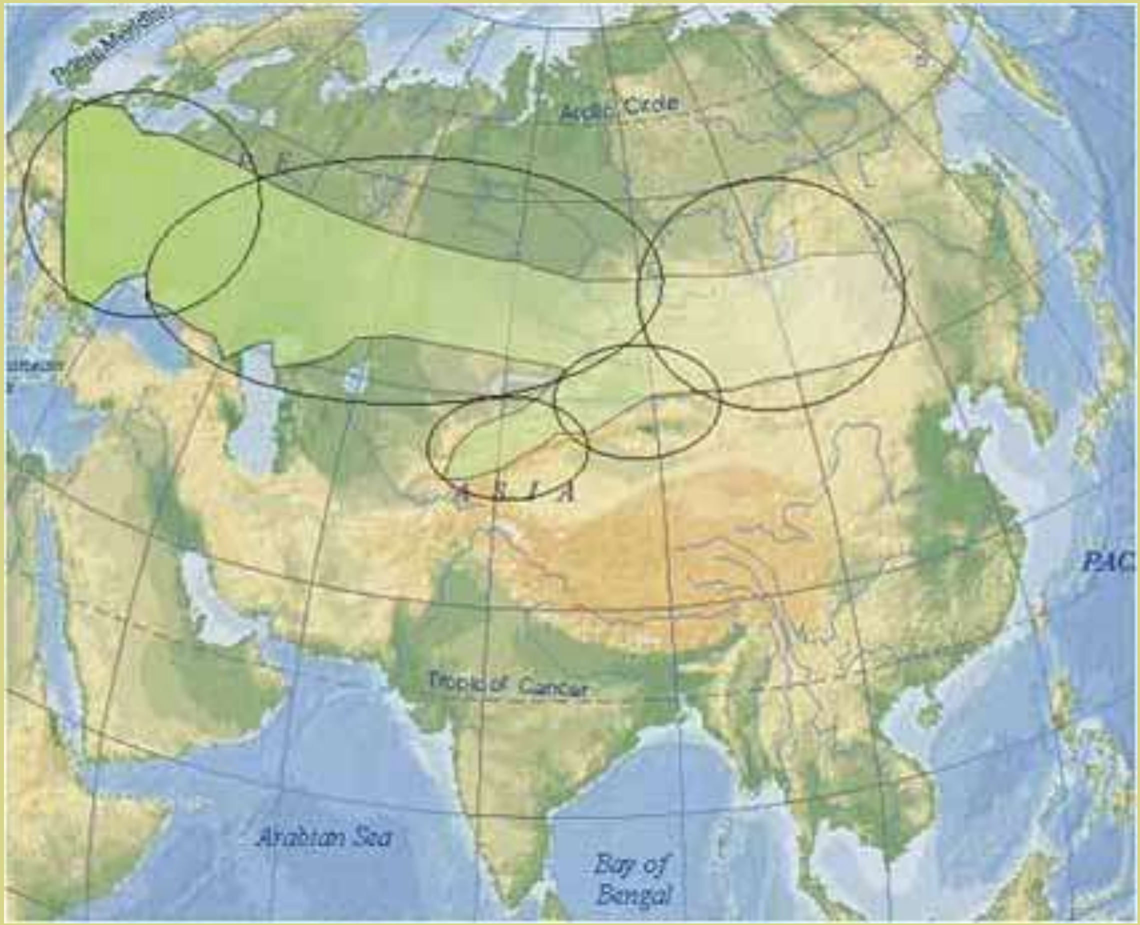
#	morph	Morphological structures on 4th antennal segment	% frequency
1	7 th	5-10 pores	32.1%
2	3 rd	5-10 pores+1 long seta	17.5%
3	6 th	4-8 pores+1 sensor setae	11%
4	22-nd	4-8 pores +1 sensor seta +1 long seta	3.6%
5	9-th	4-8 pores +1 long seta +1 long seta	3.3%
6	25-th	4 pores + 1 sensor seta + 1 sensor seta	2.9%
7	5-th	4 pores + 1 long seta+ 1 long seta + 1 long seta (on 5th segment)	2.5%

Using the analyze inner-population diversity on 15 morphological characters our research could distinguish the “chief” populations in each region in a whole distribution area. These populations contain of the most number of regional morphs:

-environs Svyatogorsk City (Ukraine),
-env. Leninka Village (Kalbinskiy Rdg., Altai, Kazakhstan),
-env. B.Vladimirovka (coniferous river valley forest, near Semipalatinsk City, East Kazakhstan),
-40 km south Tarbagatay Town, sub-alpine steppe
-env. Blagodarnoe Village (Tarbagatay Rdg., East Kazakhstan),
-10 km east Araltobe Town (Dzhungarian Mts., Kazakhstan),
-Aksay valley of Talasskiy Alatau Mts. (West Tien-Shan, Kazakhstan)
-env. Tumentsogt Town (Mongolia).

Regional populations

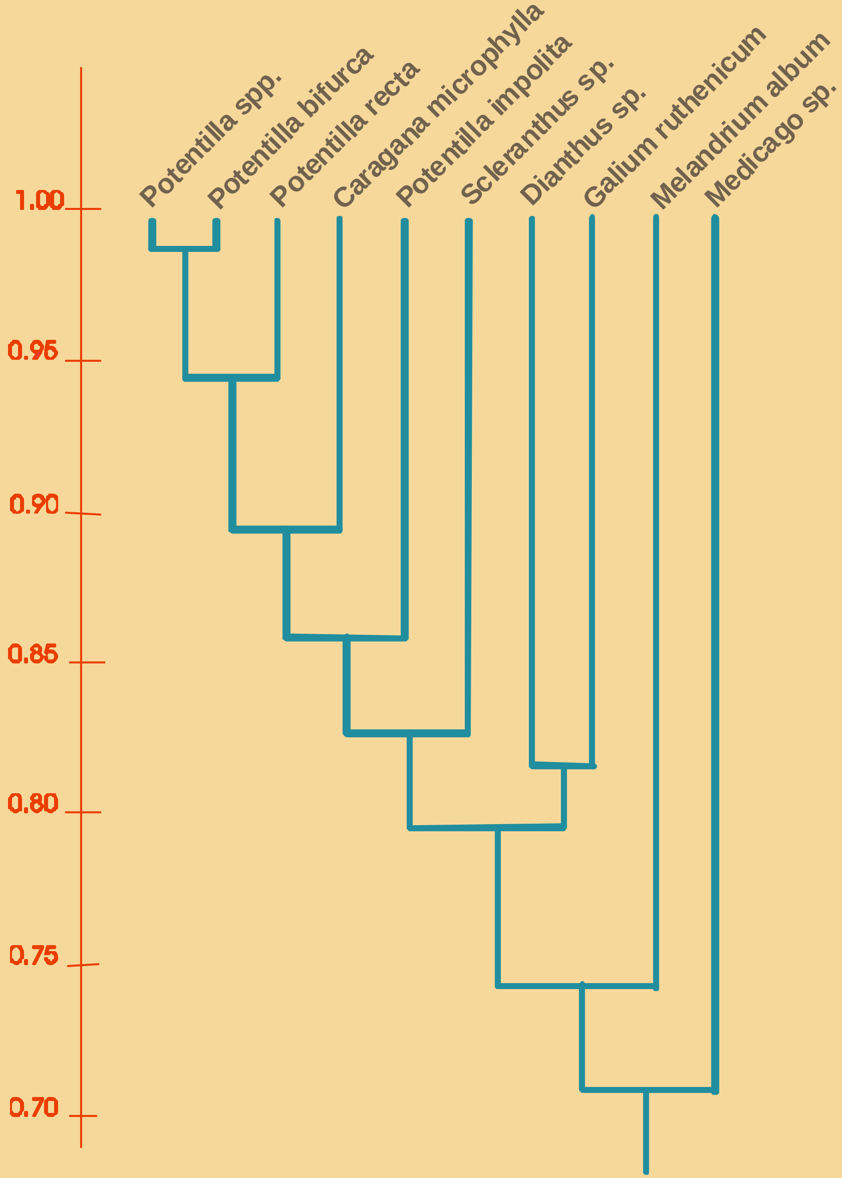




Dendrogram of similarity of regional population groups

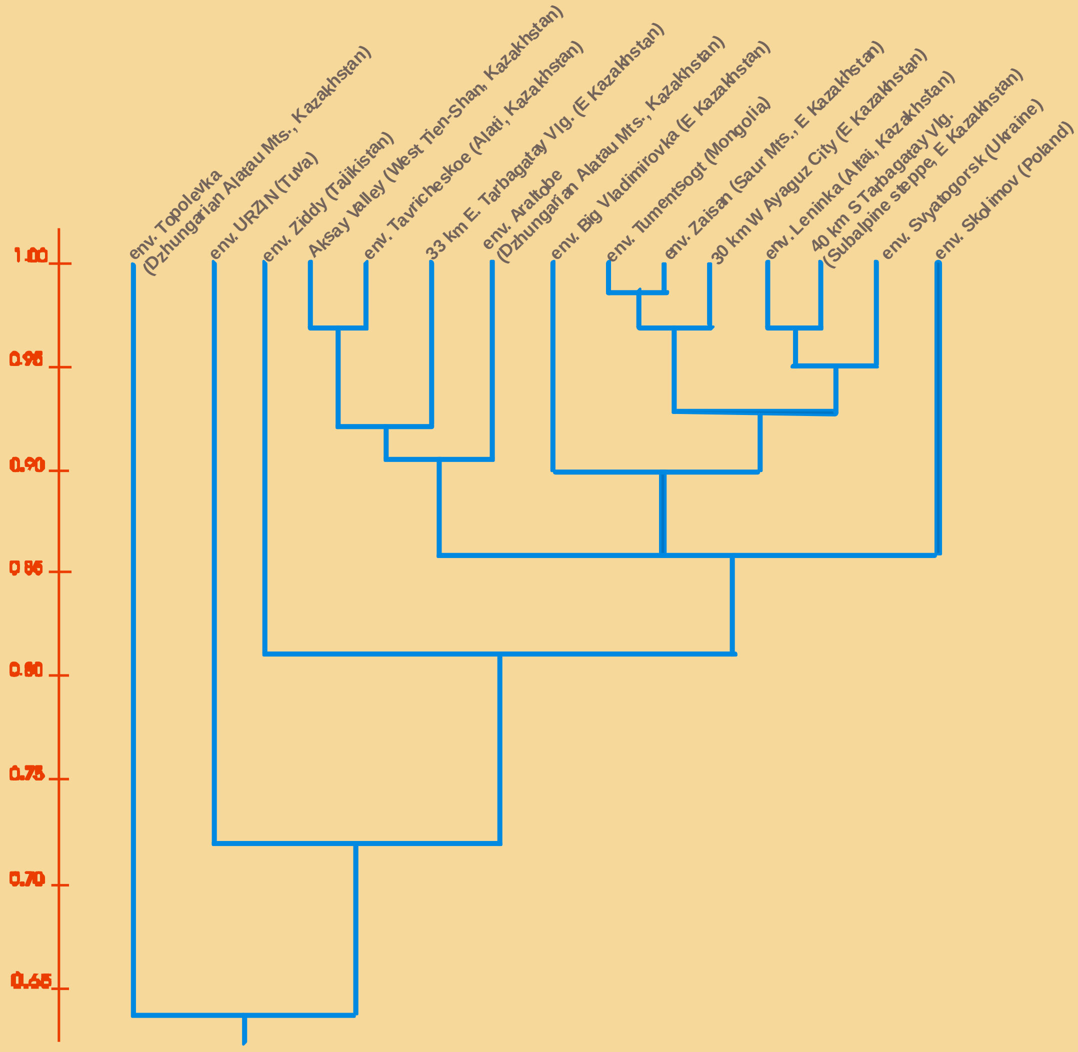
Regional groups of populations

Population groups on host-plants



Dendrogram of similarity of population groups on host-plants

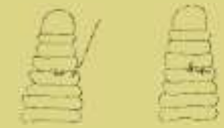
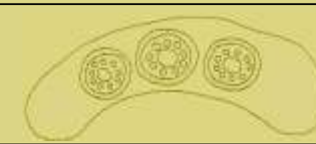
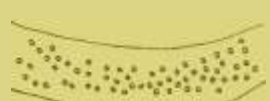
Separated populations



Dendrogram of the similarity of separate populations

Correlation of morphs corresponding to habitat humidity.

Two populations from one geographical “point” (40 km south Tarbagatay Town, Tarbagatay ridge, East Kazakhstan), living on common host-plants (*Potentilla bifurca*), but in different biotopes:

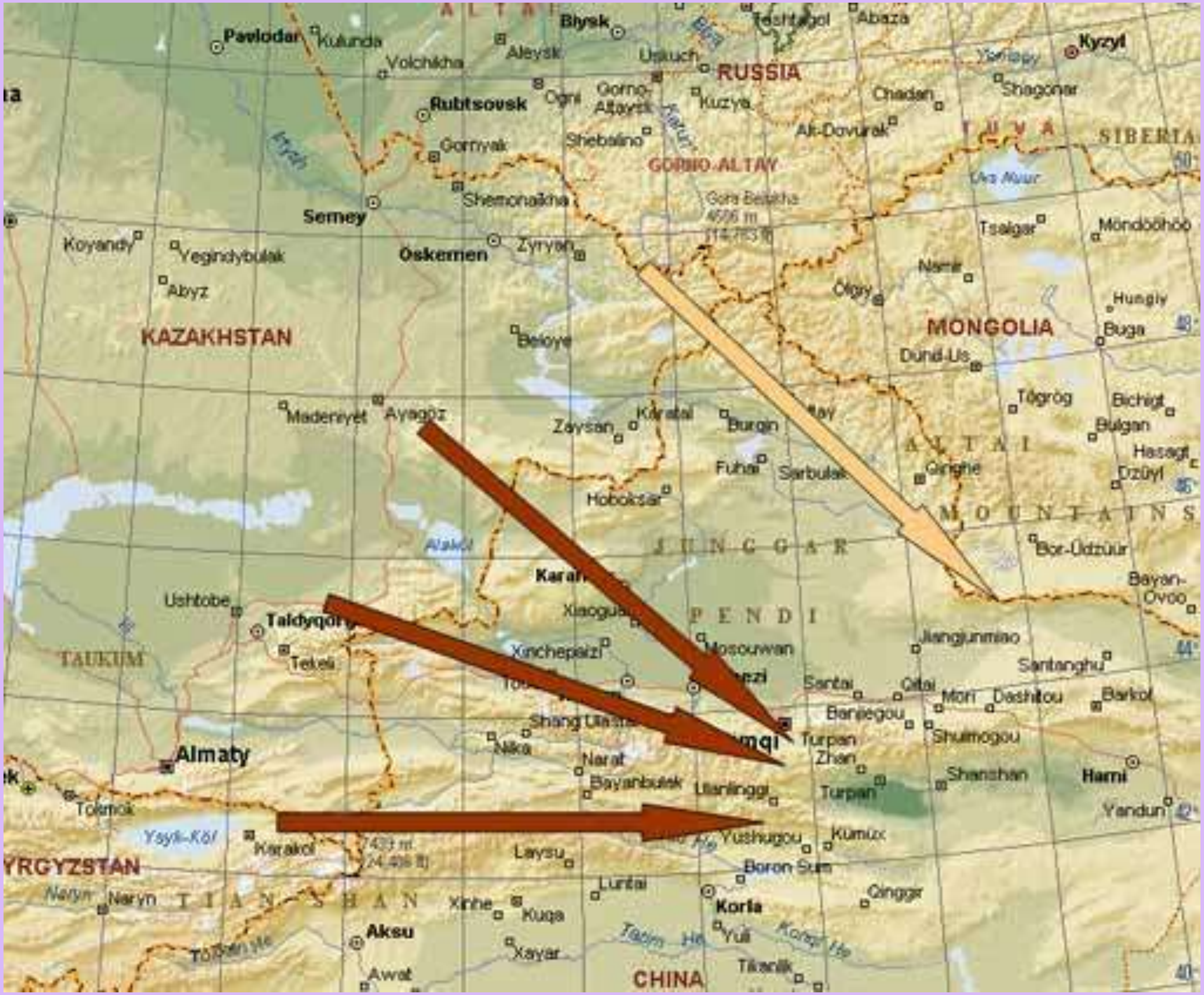
Studied characters	Biotopes	
	Dry middle-mountain steppe	**humid** sub-alpine high-mountain steppe
I	**increasing 8 segmented antennae** 	**Increasing 7 segmented antennae** 
II	**Domination of 5th morph** 	**Domination of 3rd and 6th morphs** 
III (number of sensor setae on antenna apex)	**Always 10 setae (6th morph) 7th morph is absent**	**Always 11 setae (7th morph), 6th morph is absent increased part of 8th morph (12 setae), number of sensor setae on apical antennal segment is increasing**
IV (number of long setae on antenna apex)	**Increasing long setae on apical antennal segment**	**Decreasing long setae on apical antennal segment**
V (number of multilocular pores in thoracic spiracles)	**Increasing the number (optimum is going to up)** 	**Decreasing the number (optimum is going to down)** 
VII (structures of multilocular pores in thoracic spiracle)	**Increasing the number of loculae in pores** 	**Decreasing the number of loculae in pores** 
VIII (location of multilocular pores in central part of II-V abdominal sternits	**Number of pores is increased till broad stripe 2nd morph is going down, 3rd morph is going up** 	**Number of pores is decreased 2nd morph is going up, 3rd morph is going down)**
IX (location of multilocular pores in central part of VII abdominal sternit	**Pore number is increased** 	**Pore number is decreased (but number of 2nd morph is going up)** 

Ratio of 6th and 7th morphs of III character can show the general habitat conditions.

It is some increase of numbers of multilocular pores or loculae inside pores in dry habitat conditions. Probably, it is necessary for eggs protection in dry conditions (in this cause, females produce many cotton-like secret for egg covering).

Number of multilocular pores or loculae is going up among specimens from the drier habitat

Description of the morphological characters of Xianjiang (West China) populations (prediction)



P. polonica

Biotopes: steppe biotopes of slopes and low-and middle-mountains of Mongolian Altai and other ridges, including East Tien-Shan. It inhabits the east parts of Altai, Saur, Tarbagatay and Dzhungarian Alatau ridges (morphology of these western and eastern populations in these ridges must be very similar.

Host-plants: exactly includes *Potentilla bifurca* or other species of the genus *Potentilla.*

Population morphology (female). The composition of morphs is the same for each ridge of Altai, Saur, Tarbagatay and Dzhungarian Alatau. Eastern Tien-Shan populations are rather similar, probably, to populations of Southeast Kazakhstan because of penetration there along the steppe zones from the mountain ridges of East and South-East Kazakhstan (from North Tien-Shan and Dzhungarian Alatau to Ketmen and Borokhoro ridges), as well as ridges of Central Tien-Shan (from Terskey Alatau ridge to Narat ridge).

East Tien-Shan population: Most probably, *P. polonica* lives on *Potentilla* or other host-plant "*Unknown*".

Potentilla - includes mostly dominated morphs and a little part of unique and rare morphs.

"Unknown" - part of unique and rare morphs is increased in populations.

Character I : "Potentilla" - 7-segmented antennae are dominated (not less then 70 %).
"Unknown" – part of 8-segmented antennae is high (from 30 to 80 %); most probably dominating 8-segmented antennae, if not – the portion of joined 7^{th} and 8^{th} segments is big.

Character II: *number of long, short, sensor setae and pores on II-VI (VII) segments of antenna*.
"Potentilla" – 7^{th} , 3^{rd} and 6^{th} morphs are dominated (their portion is about 70-100 %), 5^{th} , 22^{nd} , 25^{th} and 9^{th} morphs are probably absent (their portion is very little); 28^{th} , 56^{th} ,61-63^{rd} , 17^{th} and 18th are presented from the group of rare morphs (their portion is 5-30 %), the portion of unique morphs is not big – 1-10 %.
"Unknown plant" – the portion of rare and unique morphs is increased till 30-35%

Character III: "Potentilla" - the most part of female has 8-10 sensor setae on apical segments of antenna.
"Unknown" – the majority has 7-8 sensor setae on apical segments of antenna

Character IV: "Potentilla" - the majority of females with 6-7 long setae on apical segment of antenna,
"Unknown" – with 5-6 long setae.

Character V: "Potentilla" – domination of spiracles with 4-5 multilocular pores (more than 30 %),
"Unknown" – domination of spiracles with 5-6 multilocular pores the spiracle

Character VI: "Potentilla" – domination 4-5 (sometimes 6) pores near thoracic spiracles.
"Unknown" – domination 3-4 (sometimes 2) pores.

Character VII: *Location of multilocular pores in central part of abdominal segments II-V*.
If environmental conditions are dry, the locula number of multilocular pores in thoracic spiracles increase.

Character VIII: "Potentilla" - equal number of females with narrow and wide belts of pores in central part of II-V abdominal sternits, or domination females with wide belts of pores.
"Unknown" - the domination of females with narrow belts of pores.

Character IX: Females with wide belts of multilocular pores in central part of VII abdominal sternits dominate in both causes, but narrow belts is presented often in population, living on "Unknown".

Character X: "Potentilla" – the same number of females with narrow and wide belts of pores in central part of II-V abdominal tergits.
"Unknown" – females with narrow belts will dominate. In dry conditions the ability of pores will be increased.

Character XI: "Potentilla" – multilocular pores, mostly, with 1, 1.5 and 2 circles of loculae on I-VI abdominal segments.
"Unknown" – the number of loculae is less.

Character XII: Female majority has multilocular pores with 2 circles on VII-VIII abdominal segments .

Character XIII: "Potentilla" – equal portions of females with narrow and wide belts of long setae in central part of II-V abdominal sternits.
"Unknown" – females with narrow belts of setae dominate, females with 1-2 rows of setae are presented too.

Character XIV: narrow stripes of long setae in central part of II-V abdominal tergits.

Character XV: wide stripes of long setae in central part of VII abdominal tergits.

Taxonomic status of *P. ussuriensis* and *P. polonica*.

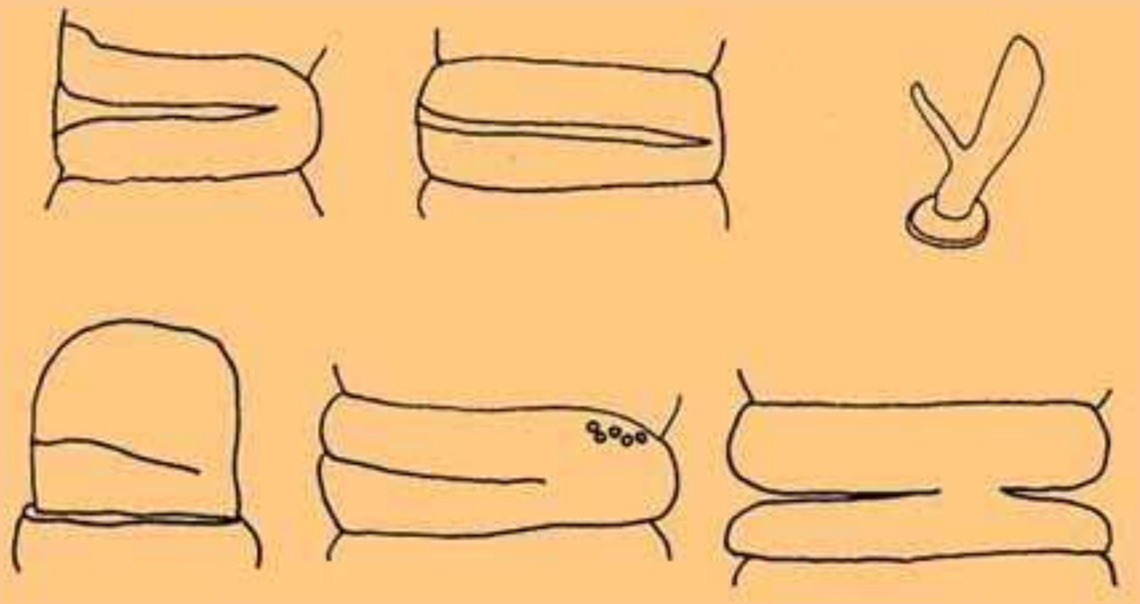
The of Ussuri carmine scale was described firstly by N.S. Borchsenius in 1949 from the environs of Grigorievka Village (Primorskiy Territory, Russian Far East). Later E.M. Danzig marked lectotype and gave the good determined description after examination of type seria and other collection material from that area (Danzig, 1980), but at the same time some characters in her description are a little different on comparison with the first description. For example, N. Borchsenius shows 8-10-segmented antennae and 7-12 multilocular pores in thoracic spiracles, E. Danzig determined 7-8-segmented antennae and 6-12 multilocular pores in thoracic spiracles.

Our studying of type seria of *P. ussuriensis* shows:

- **lectotype has 8-segmented antennae,**
  but 4th segments of both antennae are nearly divided on 2 separated segments.
  (Two from six paralectotypes have constriction, almost dividing 4th segments on two separate segments.)

- **lectotype has apical segment of one antenna with constriction also,**
  (this 8-segmented antennae could be confused as 9- or 10-segmented antennae)

- **one antenna has two-branched sensor setae**.



Populations of *P. ussuriensis* are historically the east boundary populations of *P. polonica*

the morph's variability of *P. ussuriensis* mostly is on the limits of variability of *P. polonica*.
There are some differences as well as the full commonality of host-plants and adjoining distribution areas.

The differences *P. ussuriensis* from *P. polonica* are as follow:

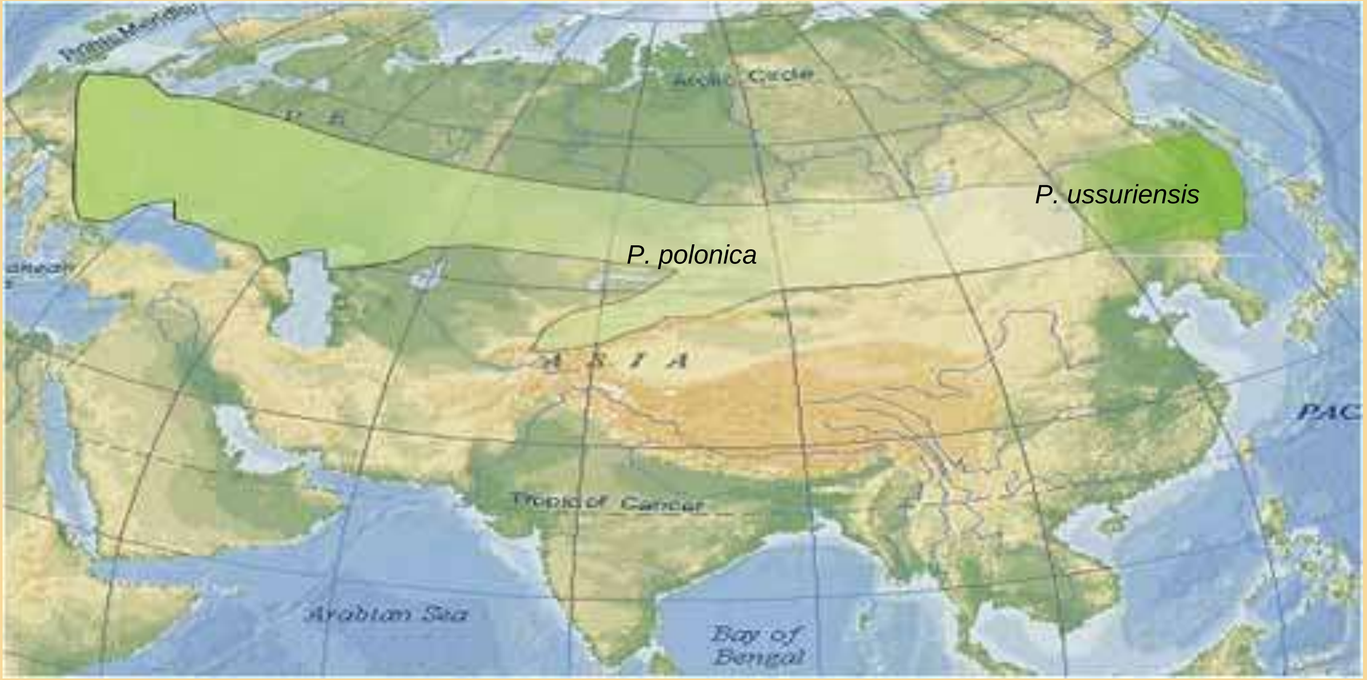
1) decreasing of length of long setae in abdomen (seta length is less than half-length of abdominal segment, abdominal seta length of Polish carmine scale is equal or more than abdominal segment length),
2) increasing number of multilocular pores in thoracic spiracles (3 morphs – 11 or 12, or 13 pores are not observed in *P. polonica*; very rare morph for *P. polonica* 10 multilocular pores in spiracle is often in population of *P. ussuriensis*),
3) increasing the portion of antenna with nearly divided 4^{th} (or 8^{th}) segments on two separated segments.

The most isolated *P. ussuriensis* population is the population of type seria

Populations of *P. ussuriensis* not long ago separated from eastern populations of polymorphous *P. polonica.*

Boundary populations of both species have not clear morphological differences.

In spite of this situation I suggest to keep a species rank for *P. ussuriensis*, because of the its most morphological isolation of type seria (according to systematic procedure and Code of Zoological Nomenclature).



Morphological abnormality and divergence of populations of *P. polonica*

Almost all populations have some non-standard morphological structures (abnormality) in antennal structure (see picture below) and structure of multilocular pores in thoracic spiracles.

The divergence

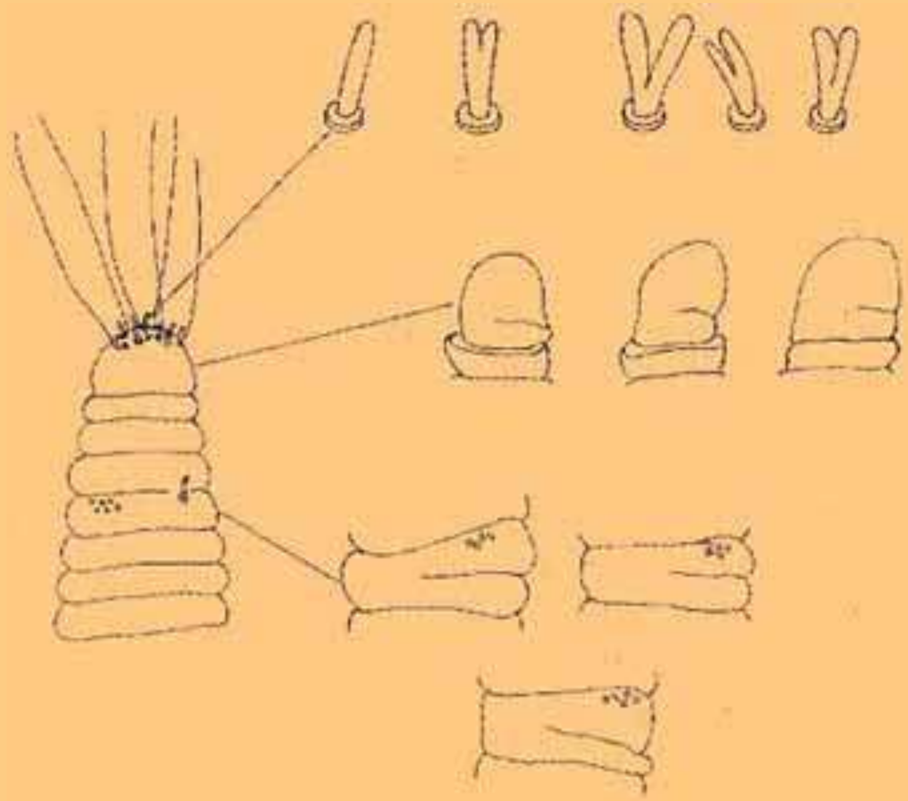
of populations of the polymorphous
Polish carmine scale
is processing on 4 ways:

I. number, localization of different structures and appearance of new structures on the antenna (characters II-IV).

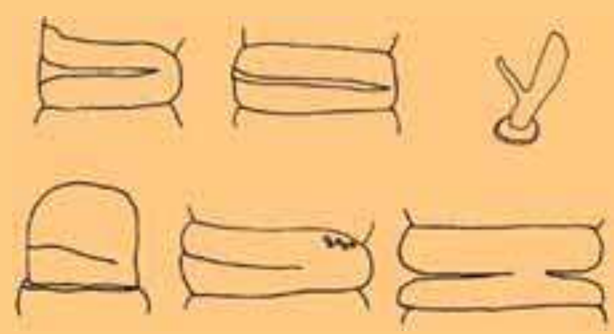
II. number and structure of simple and multilocular pores near and inside thoracic spiracles (characters V-VII),

III. structure of multilocular pores on the abdominal segments (characters XI-XII),

IV. localization of pores and setae on the body segments (characters XIII-XV).



Abnormality on antenna structure of *P. polonica*



The same abnormality on antennal structure of *P. ussuriensis*

I. number, localization of different structures and appearance of new structures on antenna (characters II-IV):

7

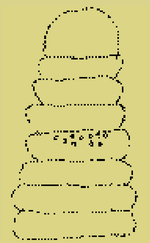
1) decreasing number of some structures

-7-segmented antenna prevails

-dominated morphs have minimum “details” such as sensor and long setae and pores,

2) concentration (localization) of some structures in one place.

- pores, long and sensor setae are concentrated on 4th antennal segment in dominated morphs (such as 7th morph with pores only, 3rd and 6th with pores and seta, 9th with pores and 2 setae)

7 

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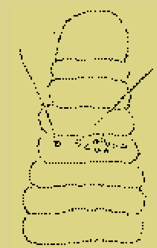
9 

3) appearance of new structures on antennal segments such as

- sensor seta with sharp top (Sarybel Village, Dzhungarskiy Alatau ridge, Kazakhstan)

- two-branched sensor setae (Belgorod City, south Russia; Aksu Valley, Talasskiy Alatau ridge, West Tien-Shan, Kazakhstan).

Closed to Polish carmine scale *Porphyrophora altaiensis* was described on the stable presence of two-branched setae on the antennal top and some other reasons (Jashenko, 1988). Probably, this species separated from *P. polonica* historically not long ago.

Dependence between long and sensor setae on the apical antennal segment:

if the number of long setae goes down the number of sensor setae goes up,

total sum of both seta type is stable - 16-20 setae.

For example, female from Poland (env. Kolisza) has antenna with 4 long and 16 sensor setae on the top (total 20) or female from east Kazakhstan (env. Zaysan Town) has 6 long 13 sensor setae (total 19).

Dependence between body size and ability of pores and setae –

if large body size the ability of setae and pores is increased.

Conclusions

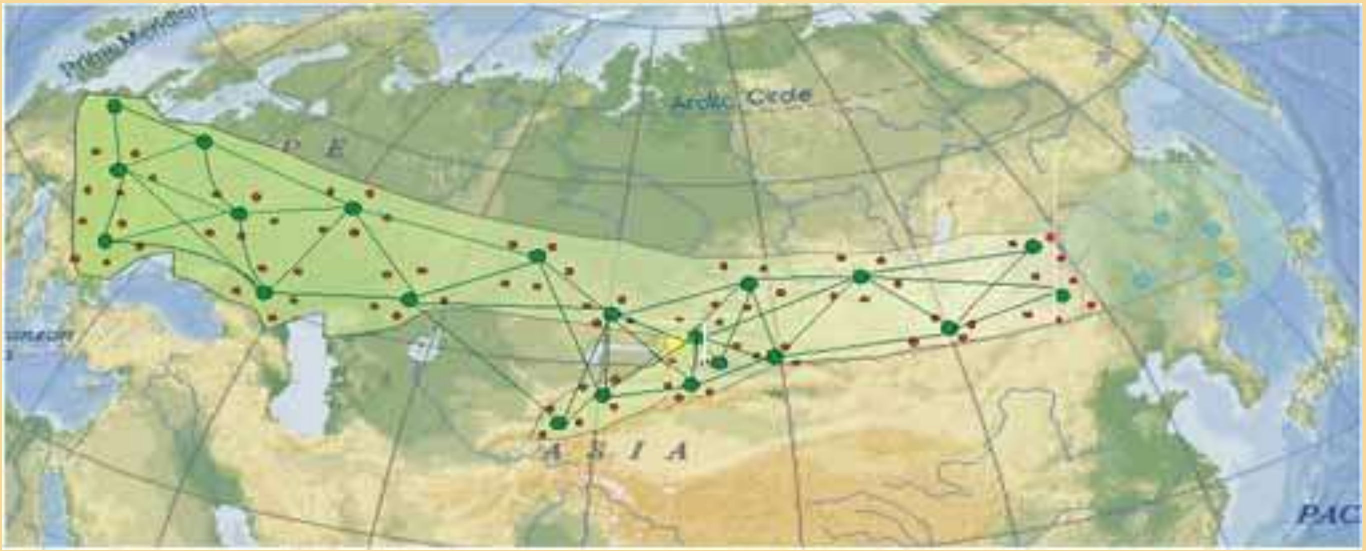
- The Polish carmine scale is very polymorphous species.

- The divergence of populations are in two ways: 1) scale up the portion of rare morphs and redistribution of dominated morphs, 2) in leaps and bounds, formation the unique morphs and increasing of their portion.

- The boundary populations (first of all, Tuvinian and south group) show the most divergence.

- Close species *P. altaiensis* and *P. ussuriensis* in recent geological time were boundary populations of Polish carmine scale in Altai and Far East.

Conclusions



- ❑ The structure of studied species consists of 2 types of populations:

“chief population” (conservative base):

- consists of the complete genetic information for each region (in different part of distribution area)
- genetically connects with each other,
- connections are as a presence of rare and dominated morphs in whole (or some parts) distribution area.
- a genetic base for other populations (“filial populations”).
- can answer on environmental request (change) only by
  1) increasing of portion of favorable (convenient for a new environmental condition) morphs from the rich genetic “arsenal”
  2) creation new morphs as a result of mutation.

✓ **“filial populations” (radical base):**

- have only some part genetic potential of regional “chief” population.
- distribute and occupy a new ecological niche,
- can survive in unfavorable conditions using own narrow genetic potential or by creation new morphs.
- have a big capacity for genetic change (its biological role)

There are “chief” population and originated from it several “filial” populations in each region.

Thank you!