

Number and arrangement variation of submarginal tubercles in adult females *Parthenolecanium corni* group (Hemiptera, Coccidae) and its value as a taxonomic character

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ABSTRACT. Evidence is provided showing that the number and arrangement of dorsal submarginal tubercles are not a reliable character to separate species or subspecies in the genus *Parthenolecanium*. A morphomeristic analysis of 756 adult females collected of 22 different host plants shows that dorsal tubercles are highly variable in number and arrangement and this character is of little diagnostic value on the species or subspecies levels.

KEY WORDS: *Parthenolecanium corni* group, adult females, submarginal tubercles, variations, taxonomic value

INTRODUCTION

Submarginal tubercles (Fig. 1) occur on more than half of the species of the family *Coccidae*. They can be present in adult females as well as in the second or third female instar larvae from the subfamily *Coccinae*. These morphological structures are restricted to the margin of the body (e.g. in *Coccus*, *Parthenolecanium*, *Pulvinaria*, *Saissetia*) and they are arranged in one, rarely two, rows along the submargins. They secrete wax.

Submarginal tubercles are variable in structure, size and number. According to HODGSON (1997), they fall into two main types: tubercles with only one wide central tubular duct (as in *Coccus*, *Parthenolecanium* and *Saissetia*) and tubercles with a wide central tubular duct surrounded by small satellite tubular ducts (as in *Etiennae*). The size of submarginal tubercles varied between 7.4 µm (e.g. in *Coccus hesperidum* L.) and 31.3 µm (e.g. in *Parthenolecanium persicae* (FABRICIUS) in diameter (WILLIAMS & KOSZTARAB 1972). ŁAGOWSKA (1996) found that the size of submarginal tubercles in adult females of

Pulvinaria vitis (L.) varied between 5.0 and 15.0 μm in diameter and their distance from the margin varied from 25.0 to 80.0 μm . The variability of these parameters was observed in specimens from the same host and even in a single female. The numbers of submarginal tubercles were found to be highly variable in *Parthenolecanium corni* (DZIEDZICKA & SERMAK 1967), *Pulvinaria vitis* (ŁAGOWSKA 1996, 1997), *Coccus hesperidum* (ŁAGOWSKA 1999) and *Parthenolecanium persicae* (ŁAGOWSKA 2005).

Submarginal tubercles are important taxonomic features at all levels although they are variable in size, number and arrangement. They serve as taxonomic character to separate some genera and species of *Coccidae*, e.g. they are used to separate species in the genus *Parthenolecanium* (GILL 1988, KOSZTARAB & KOZAR 1988, KOSZTARAB 1996).

The present study was undertaken to investigate the range of variation of submarginal tubercles in adult females of *Parthenolecanium* species, depending on the host plant. Also, the usefulness of this character in separating species in the genus *Parthenolecanium* is estimated.

There exists considerable uncertainty in regard to the identity of *Parthenolecanium* species. The species recorded in Europe on trees and bushes include: *P. corni*, *P. persicae*, *P. fletcheri*, *P. pomeranicum*, *P. rufulum* and almost all of them (except *P. persicae*) are morphologically very similar. They share many of the same morphological characters, which show a great variation, including characters which are normally used in classification, and all species discussed are difficult to determine. In addition, some members of this genus (*P. pomeranicum*, *P. rufulum*, *P. fletcheri*) tend to be found on only a few plant species, while others (*P. corni*, *P. persicae*) are extremely polyphagous and they can live on the same host plants, together with the others, e.g. with *P. rufulum* or *P. pomeranicum*. Therefore, all specimens are treated in this work as *Parthenolecanium corni* group.

MATERIAL AND METHODS

Adult females of *Parthenolecanium corni* group were collected from 22 host plants at several localities (botanical garden, parks, orchards) in Lublin and its vicinity. A total of 756 adult females were examined on microscopic slides.

The observations of slide-mounted specimens were made using a Nikon Eclipse E600 microscope (magnifications used were 20 \times and 40 \times). Statistical analysis involved calculating the mean and variability range and variance analysis (ANOVA) using Statistica 6.0.

RESULTS

Submarginal tubercles were present or absent in specimens collected on the same host plant. In the samples off *Crataegus* (Rosaceae), *Lonicera*, *Symphoricarpos* (Caprifoliaceae)

and *Robinia* (Fabaceae) from 52.2% to 72.7% of adult females with submarginal tubercles were found, while in the samples from *Taxus* and *Quercus*, only 1.4% and 5.2% specimens, respectively, had submarginal tubercles (Table 1).

Table 1. Percentage of adult females *Parthenolecanium corni* group with submarginal tubercles

Host plant family	Host plant	Number of females examined	Per cent of females with tubercles
Buxaceae	<i>Buxus</i>	13	23.1
Caprifoliaceae	<i>Lonicera</i>	21	52.4
	<i>Symphoricarpos</i>	12	58.3
	<i>Viburnum</i>	9	11.1
Cercidiphyllaceae	<i>Cercidiphyllum</i>	10	20.0
Cornaceae	<i>Cornus</i>	23	43.5
Corylaceae	<i>Corylus</i>	59	45.0
Fabaceae	<i>Acacia</i>	36	36.1
	<i>Caragana</i>	29	10.3
	<i>Robinia</i>	22	72.7
Fagaceae	<i>Quercus</i>	101	5.2
Hippocastanaceae	<i>Aesculus</i>	45	15.5
Rosaceae	<i>Cotoneaster</i>	25	36.0
	<i>Crataegus</i>	23	52.2
	<i>Cydonia</i>	11	18.2
	<i>Prunus</i>	75	37.3
	<i>Rosa</i>	32	40.6
	<i>Rubus</i>	10	40.0
Salicaceae	<i>Salix</i>	25	20.0
Tamaricaceae	<i>Tamarix</i>	14	28.6
Taxaceae	<i>Taxus</i>	141	1.4
Tiliaceae	<i>Tilia</i>	20	45.0

The means and ranges for submarginal tubercles for specimens collected from different host plants are presented in Table 2. These parameters were different depending on the host plant. The largest mean values were noted for specimens off *Robinia* (10.3), *Tilia* (6.8), *Tamarix* (6.4) and *Crataegus* (6.2). In the sample off *Taxus* and off *Quercus*, the mean values of submarginal tubercles were the smallest in comparison with those from the other host plants. (Table 2).

Table 2. Means and ranges of submarginal tubercles of adult female *Parthenolecanium corni* group collected on different host plants in Poland

Host plant family	Host plant	Number of females examined	Mean	Range
Buxaceae	<i>Buxus</i>	13	2.5	0–18
Caprifoliaceae	<i>Lonicera</i>	21	5.0	0–18
	<i>Symphoricarpos</i>	12	5.7	0–20
	<i>Viburnum</i>	9	1.3	0–12
Cercidiphyllaceae	<i>Cercidiphyllum</i>	10	2.8	0–18
Cornaceae	<i>Cornus</i>	23	5.0	0–17
Corylaceae	<i>Corylus</i>	59	4.8	0–22
Fabaceae	<i>Acacia</i>	36	3.6	0–16
	<i>Caragana</i>	29	0.4	0–10
	<i>Robinia</i>	22	10.3	0–18
Fagaceae	<i>Quercus</i>	101	0.04	0–1
Hippocastanaceae	<i>Aesculus</i>	45	1.7	0–23
Rosaceae	<i>Cotoneaster</i>	25	4.4	0–19
	<i>Crataegus</i>	23	6.2	0–16
	<i>Cydonia</i>	11	1.1	0–10
	<i>Prunus</i>	75	4.6	0–22
	<i>Rosa</i>	32	4.8	0–18
	<i>Rubus</i>	10	6.0	0–18
Salicaceae	<i>Salix</i>	25	1.9	0–19
Tamaricaceae	<i>Tamarix</i>	14	6.4	0–20
Taxaceae	<i>Taxus</i>	141	0.01	0–1
Tiliaceae	<i>Tilia</i>	20	6.8	0–20

Among 756 adult females studied the number of dorsal tubercles varied from 0 to 23. The greatest numbers of dorsal tubercles (20–23) were noted on specimens off *Symphoricarpos*, *Corylus*, *Prunus*, *Tamarix*, *Tilia* and *Aesculus* (Table 2). Only 1.05% of the specimens possessed from 20 to 23 dorsal tubercles, which is regarded as the highest range of this character in adult females studied.

Submarginal tubercles also showed considerable variation in arrangement within the same sample regardless the host plant on which they were collected; e.g. among 4 females collected on *Robinia* and having 14 gland 4 patterns of arrangement were found. Various

combinations of distribution of submarginal tubercles in adult females collected on *Robinia* and *Corylus* are presented on Figs 2 & 3.

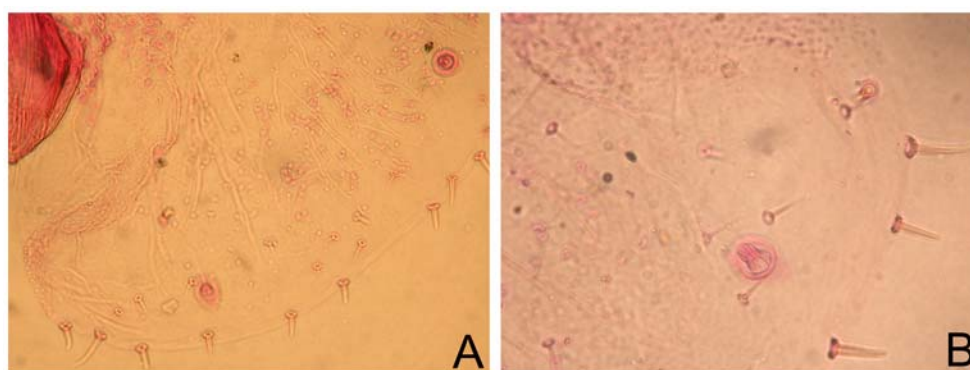


Fig. 1. Dorsal submarginal tubercles in adult female *P. corni* group collected on *Aesculus*. A – magnification 10×, B - magnification 20×.

Table 3. Analysis of variance of dorsal tubercles number recorded from adult females *Parthenolecanium corni* group

	SS between group	Degree of freedom	Between - groups variance	SS within group	Degree of freedom	Within- group variance	F value	Signifi cance
dt	5126.561	21	244.1219	19123.19	741	25.80727	25.80727	✱

✱ – significantly different at level 0.05

Simple analysis of variance (ANOVA) demonstrated that there were significant differences between the samples compared at the level 0.05 (Table 3).

Statistical significances were found for 16 samples compared. The samples that differed one from another are specified in Table 4.

Analysis of means performed by applying post-hoc HSD Tukey's RIR test indicated that sample off *Robinia* differed significantly from 13 another samples compared, while for the samples off *Tamarix*, *Cerasus*, *Rubus*, *Corylus*, *Lonicera*, *Symphoricarpos* and off *Tilia* insignificant differences were found (Table 4).

DISCUSSION

A morphomeristic analysis of *Parthenolecanium* adult females collected in Poland showed that the number of submarginal tubercles is much more variable than could be expected from the number ranges described by the many authors. WILLIAMS & KOSZTARAB

Table 4. Post-hoc HSD Tukey's RIR test results

	Tam	Cot	Cor	Pru	Rob	Sal	Bux	Cra	Cer	Rub	Tax	Aca	Car	Cor	Cyd	Lon	Sym	Aes	Que	Til	Vib	Ros	
Tam	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Cot	○	○	○	✖	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Cor	○	○	○	✖	○	○	○	○	○	✖	○	○	○	○	○	○	○	○	✖	○	○	○	○
Pru	○	○	○	○	✖	○	○	○	○	○	✖	○	○	○	○	○	○	○	○	✖	○	○	○
Rob	○	✖	✖	✖	○	✖	✖	○	○	○	✖	✖	✖	○	✖	○	○	○	✖	✖	○	✖	✖
Sal	○	○	○	○	✖	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Bux	○	○	○	○	✖	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Cra	○	○	○	○	○	○	○	○	○	○	✖	○	✖	○	○	○	○	○	○	✖	○	○	○
Cer	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Rub	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Tax	○	○	✖	✖	✖	○	○	✖	○	○	○	○	○	○	○	○	○	○	○	○	✖	○	✖
Aca	○	○	○	○	✖	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Car	○	○	○	○	✖	○	○	✖	○	○	○	○	○	○	○	○	○	○	○	○	✖	○	○
Cor	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Cyd	○	○	○	○	✖	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Lon	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Sym	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Aes	○	○	○	○	✖	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Que	○	○	✖	✖	✖	○	○	✖	○	○	○	○	○	○	○	○	○	○	○	○	✖	○	✖
Til	○	○	○	○	○	○	○	○	○	○	✖	○	✖	○	○	○	○	○	○	○	✖	○	○
Vib	○	○	○	○	✖	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	✖	○
Ros	○	○	○	○	✖	○	○	○	○	○	✖	○	○	○	○	○	○	○	○	○	✖	○	○

Tam – *Tamarix*, Cot – *Cotoneaster*, Cor – *Corylus*, Pru – *Prunus*, Rob – *Robinia*, Sal – *Salix*, Bux – *Buxus*, Cra – *Crataegus*, Cer – *Cercidiphyllum*, Rub – *Rubus*, Tax – *Taxus*, Aca – *Acacia*, Car – *Caragana*, Cor – *Cornus*, Cyd – *Cydonia*, Lon – *Lonicera*, Sym – *Symphoricarpos*, Aes – *Aesculus*, Que – *Quercus*, Til – *Tilia*, Vib – *Viburnum*, Ros – *Rosa*.

✖ - significantly different at level 0.05; ○ - insignificant

(1972) presented females of *Parthenolecanium corni* from Virginia as having up to 12 dorsal tubercles, while KOSZTARAB (1996) found up to 18 tubercles in specimens from North America. Only adult females of *P. corni* from California had up to 24 tubercles (GILL 1988). According to KOSZTARAB & KOZAR (1988) the number of dorsal tubercles varied from 0 to 18 in Central Europe. In Poland DZIEDZICKA & SERMAK (1967) found out from 2 to 18 tubercles in *P. corni* adult females collected on *Taxus baccata*. The present study

indicates that this character exhibited broader ranges of variation, in the females studied from 0 to 23 tubercles have been found.

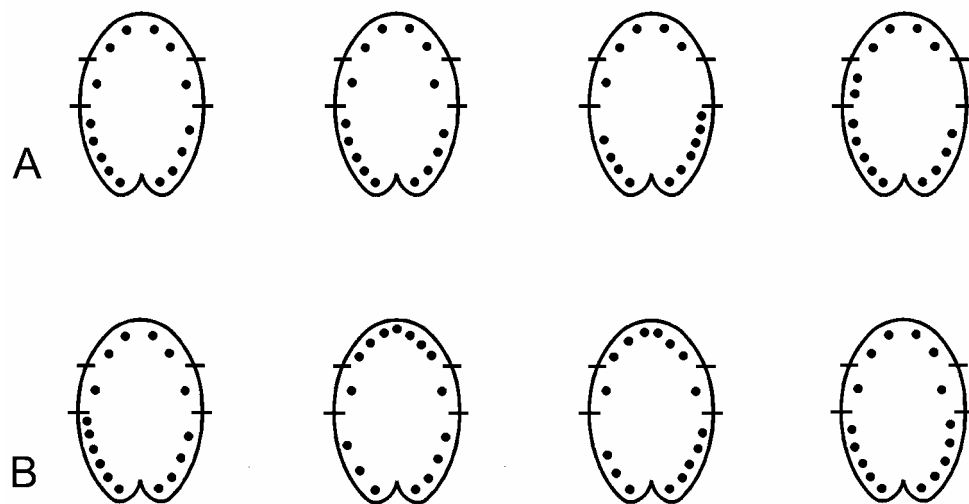


Fig. 2. Various combinations of arrangement of submarginal tubercles in adult females *P. corni* group collected on *Robinia*. A - various combinations of arrangement of 15 submarginal tubercles, B - various combinations of arrangement of 16 submarginal tubercles.

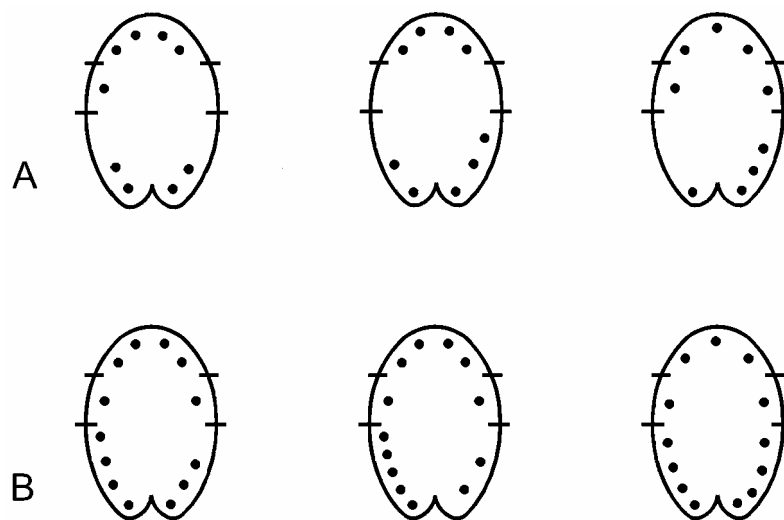


Fig. 3. Various combinations of arrangement of submarginal tubercles in adult females *P. corni* group collected on *Corylus*. A - various combinations of arrangement of 11 submarginal tubercles, B - various combinations of arrangement of 13 submarginal tubercles.

Analyzing the mean number of submarginal tubercles, we arrive at the conclusion that all of the samples showed different values depending on the host plant from which the specimens derived. Morphological variation of scale insects has been reported to be influenced by some environmental factors. Host plant species appear to be the principal factor in morphological variation. Based on host transfer experiments, EBELING (1938) and HABIB (1957) concluded that some structural variations in *P. corni* were affected by host. Similar results were obtained for *P. vitis* by MALUMPHY (1991) and ŁAGOWSKA (1996). ŁAGOWSKA (1996, 1997) found that host plant species could influence the number of submarginal tubercles, while temperature had no effect on this feature in *P. vitis*.

Submarginal tubercles were used as important features at different taxonomic levels. They served as a taxonomic character to separate some genera and species or subspecies of *Coccidae*, e.g. the adult females from Korea, China and Japan having 12 pairs of dorsal tubercles were treated by BORCHSENIUS (1957) as a separate subspecies, *P. corni orientalis*. Similarly, a subspecies *P. corni apulia* from Italy on *Vitis sp.* on the basis of this character has been described by NUZZACI (1969).

The present study indicates that submarginal tubercles were highly variable in number and distribution and this feature is of little diagnostic value on the species and subspecies levels. The presence of dorsal tubercles is a good character on higher taxonomic categories, e.g. these structures is very important for placing genus *Parthenolecanium* in the subfamily Coccinae.

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