MORPHOLOGICAL STUDIES ON THE OCCIPITAL REGION OF NYMPHALIDAE AND LIBYTHEIDAE (LEPIDOPTERA) FROM JAPAN

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I. INTRODUCTION

A considerable number of studies have been carried out on the occipital morphology of moths since YAGI and KOYAMA's report of 1963 (KOYAMA and MIYATA, 1969, 1970, 1975 ; MIYATA, 1971, 1972, 1973, 1974, 1975 ; MIYATA and KOYAMA, 1971, 1972, 1976).

In the butterflies, however, few papers were available concerning the occipital region, on which EHRLICH (1958, a b), YAGI and KOYAMA (1963) and KOYAMA and OGAWA (1972) briefly described. Then, tried to study the occipital region of butterflies, the authors observed it preliminarily (TSUBUKI et al. 1975).

The present paper deals with the occipital structure of Nymphalidae and Libytheidae from Japan with reference to its bearing on systematics.

Before going further, the authors wish to express their gratitude to Prof. Dr. H. SAWADA and Prof. Dr. N. GOKAN, Tokyo University of Agriculture, for their advice and assistance. Thanks are also due to Mr. N. KÔDA who gave valuable materials for this work, and to Mr. Y. YAGUCHI and the members of JEOL Ltd. who took pictures with scanning electronic microscope.

II. MATERIALS AND METHODS

The observation of the occipital region was mainly made by a binocular microscope after removal of the scales, and the Sump method was applied to the surface structure. Besides the structure of several species was investigated with a scanning electronic microscope.

The materials used for this study were 54 species in 2 families, which are shown in the following. The scientific name is due to "Coloured Illustrations of the Butterflies of Japan" by KAWAZOE and WAKABAYASHI (1976).

NYMPHALIDAE

Melitaeinae

Melitaea scotosia BUTLER
M. diamina regama FRUHSTORFER
Mellicta athalia niphona BUTLER

Argynninae

Phalanta phalantha DRURY
Clossiana iphigenia sachalinensis MATSUMURA
C. thore jezoensis MATSUMURA
Brenthis daphne rabdia BUTLER
B. ino tigroides FRUHSTORFER
Argyronome laodice japonica MÉNÉTRIÈS
A. ruslana lysippe JANSON
Damora sagana ilona FRUHSTORFER
Nephargynnis anadyomene midas BUTLER
Argynnis paphia geisha HEMMING
Speyeria aglaja fortuna JANSON
Fabriciana adippe pallescens BUTLER
F. nerippe C. & R. FELDER
Argyreus hyperbius LINNAEUS

Limenitinae

Athyma selenophora ishiana FRUHSTORFER
Limenitis (Ladoga) glorifica FRUHSTORFER
L. (L.) camilla japonica MÉNÉTRIÈS
L. populi jezoensis MATSUMURA
Neptis sappho intermedia W. B. PRYER
N. hylas luculenta FRUHSTORFER

N. philyra excellens BUTLER
N. pryeri BUTLER
N. alwina kaempferi DE L'ORZA
N. rivularis insularum FRUHSTORFER

Nymphalinae

Araschnia burejana strigosa BUTLER
A. levana obscura FENTON
Polygonia c-aureum LINNAEUS
P. c-album hamigera BUTLER
Nymphalis vau-album samurai FRUHSTORFER
N. xanthomelas japonica STICHEL
N. antiopa asopos FRUHSTORFER
Kaniska canace no-japonicum VON SIEBOLD
Inachis io geisha STICHEL
Aglais urticae esakii KUROSAWA & FUJIOKA
Cynthia cardui LINNAEUS
Vanessa indica HERBST
Precis orithya LINNAEUS
P. almana LINNAEUS
Hypolimnas misippus LINAEUS
H. bolina kazia BUTLER
Kallima inachus formosana FRUHSTORFER
Yoma sabina vasuki DOHERTY

Apaturinae

Hestina japonica C. & R. FELDER
H. assimilis formosana MOORE
Sasakia charonda HEWITSON
Apatura ilia substituta BUTLER
Dichorragia nesimachus nesiotes FRUHSTORFER

Marpesiinae

Cyrestis thyodamas formosana FRUHSTORFER

Charaxinae

Polyura eudamippus formosana ROTHSCHILD
P. narcaea meghaduta FRUHSTORFER

LIBYTHEIDAE

Libythea celtis celtoides FRUHSTORFER

III. GENERAL MORPHOLOGY OF THE OCCIPITAL REGION (Fig. 1)

The occipital region of Nymphalidae and Libytheidae consists of three main parts, viz. dorsal part of occiput, postocular plate and occipital foramen. A ratio of the width (W) to the height (H) of the occiput (W/H ratio) is 1.7~2.6 as shown Table 2. Generally the coloration of the occiput takes dark brown or black, though several species bear partially yellowish brown.

1. Dorsal part of occiput (Fig. 1, Dpo)

The dorsal part of occiput is shaped like a reversed trapezoid. This part differs remarkably in the occipital structure according to group or species, and so contributes to the diagnostic indicator of butterflies. It is divided into occipital prominence, intermediate plate and connection part. Except for the last it is covered with scales (Photo 146). The occipital prominence varies from high (e. g. Limenitinae) to low (e. g. Marpesiinae) in rising feature.

The coloration is different to some extent in each species or group ; for example the whole part of Limenitinae has black coloration and of *Kallima inachus* yellow, the occipital prominence and the intermediate plate take black and yellowish brown, respectively in Argynninae.

A ratio of the dorsal width (w) to the marginal height (h) (w/h ratio) is 1.5~3.3 (Table 2), and that of the dorsal width (w) to the width of the occiput (w/W ratio) is 0.29~0.53 (Table 2).

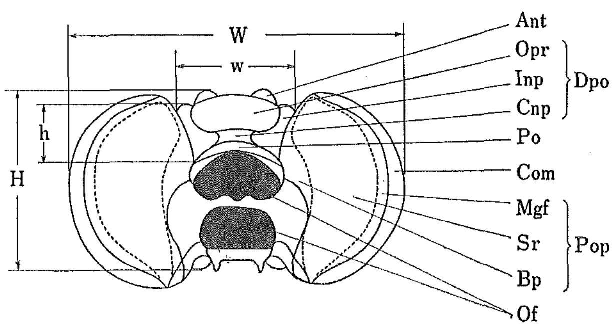

Fig. 1. Occipital region of Japanese Nymphalidae.
Ant–Antenna, Bp–Basal part, Cnp–Connection part, Com–Compound eye, Dpo–Dorsal part of occiput, Inp–Inner plate, Mgf–Marginal furrow, Of–Occipital foramen, Opr–Occipital prominence, Po–Postocciput, Pop–Postocular plate, Sr–Scale region.

2. **Postocular plate** (Fig. 1, Pop)

The postocular plate is divisible into marginal furrow, scale region and basal part.

a) *Marginal furrow* (Fig. 1, Mgf)

A ratio of the furrow width (F) to the facetal diameter (d) (F/d ratio) varies widely 2.0~6.3 (Table 2). In some species, it bears small setae, tubercles or sutures, of which patterns are generally classified into three types. The first type, which is seen in many species, has rich parallel sutures along the margin of compound eye. The second type is furnished by proximally running sutures, as found in *Argynnis paphia geisha* (Photo 74). The third type bears network sutures, as observed in *Nymphalis xanthomelas* (Photo 94). The periphery of compound eye is covered densely with small tubercles (Photo 124, 133), of which the size is bigger than that of corneal nipples. Much bigger ones grow in the distal part of the marginal furrow in most species.

b) *Scale region* (Fig. 1. Sr)

The scale region has small setae and tubercles in some species (e. g. *Dichorragia nesimachus nesiotes*, Photo 111). Besides the part is provided with such sutures as seen in the marginal furrow (Photo 86, 94, 101). The basal part of the occiput bears small setae densely.

Table 1. Morphological characters of occipital region in each subfamily of Nymphalidae and Libytheidae.

	$\frac{W}{H}$	$\frac{w}{h}$	$\frac{w}{W}$	$\frac{F}{d}$	Total density	Protuberance of Opr.	Color of Opr. and Inp.
Nymphalidae							
Melitaeinae	1.9	2.3	0.42	3.1	3.7	high	same
Argynninae	2.1	2.4	0.44	3.2	0.9	〃	different
Limenitinae	1.8	1.7	0.35	3.2	7.1	〃	same
Nymphalinae	2.1	2.7	0.42	4.6	2.6	low	〃
Apaturinae	1.9	2.1	0.38	4.2	12.5	〃	different
Dichorragia	1.8	2.0	0.37	2.5	14.0	high	〃
Marpesiinae	1.8	1.5	0.29	4.6	2.0	low	〃
Charaxinae	2.3	3.1	0.51	5.2	3.0	〃	same or different
Libytheidae	2.5	2.9	0.40	2.3	8.0	low	same

c) *Sensory organ*

Sensory organ is distributed in the occipital region. It is believed to be a receptor of some mechano-stimulation, though its role yet unknown. Two sensory organs generally lie in the postocular plate. The one is at the dorsal part of the scale region and the other at the center of the marginal furrow. In some species the sensory organ locates at the basal part and the postocciput (e. g. *Inachis io geisha*, Photo 127). The structure of the sensory organ seems to be different according to group. Its center protrudes in *Dichorragia nesimachus nesiotes* (Photo 130), *Inachis io geisha* (Photo 128) and so on, while it is depressed in *Argynnis anadiomene midas* (Photo 119) and *Sasakia charonda* (Photo 135).

d) *Small setae and tubercles*

As above mentioned, small setae and tubercles are seen in the marginal furrow and/or the scale region in most species. The occipital type proposed by KOYAMA and MIYATA (1969) was also used in this paper. In butterflies, however, the boundary is indistinguishable between the scale band and the inner plate, so the authors divided the postocular plate into four parts such as the marginal furrow and the scale region into two parts, respectively. Their density was orderly indicated by A (absent), P_1 (sparse), P_2 (medial) and P_3 (dense), and was given the value of 0, 1, 3, 5, to the respective indicator. According to this expression, for example, the occipital type of *Sasakia charonda* becomes P_3P_3–P_3A, the total density being 15.

IV. OCCIPITAL STRUCTURE OF EACH SPECIES IN NYMPHALIDAE AND LIBYTHEIDAE

A. NYMPHALIDAE

1. Melitaeinae

In this group the occipital prominence protrudes remarkably towards the posterior direction (Photo 54). Both the occipital prominence and the intermediate plate are melanized strongly. The dorsal end of the intermediate plate projects a little in *Melitaea* but not in *Mellicta*. The values of W/H ratio and w/h one are 1. 9 and 2. 3, respectively (Table 1). The width of the marginal furrow in *Mellicta* (F/d=4. 4) is clearly wider than that in *Melitaea* (F/d=2. 5). Besides small setae and tubercles are rather denser in the former than in the latter.

1) *Melitaea*

M. scotosia (Photo 1, 54, 62) The occipital prominence is not so protuberant dorsally. Its structure is closely similar to that of Argynninae, though differs in having the intermediate plate which is melanized as well as the occipital prominence. Small tubercles are poor. The occipital type is P_1A–AA.

M. diamina legama (Photo 2, 63) This species, especially in the male, has the remarkably protruded dorsal part in the occipital prominence. Melanization of the male is stronger than that of the female. The marginal furrow is narrowest (F/d=2. 0) in Nymphalidae. A few small setae and tubercles are found there. The occipital structure belongs to P_1P_1–AA type.

2) *Mellicta*

M. athalia niphona (Photo 3, 64) The dorsoventral width of the occipital prominence varies according to individual. The marginal furrow is wide (F/d= 4. 4). Small setae and tubercles are grown in the marginal furrow and the scale region. The occipital type is P_2P_1–P_2P_1.

2. Argynninae

The structure of the dorsal part of occiput in Argynninae resembles that in Melitaeinae very much. But it differs from the latter in the coloration of the intermediate plate which is weaker. The shape of the occipital prominence is roundish in some genera (e. g. *Argyronome*, *Damora*, *Argynnis*), while flat at the dorsal part in the others (e. g. *Phalanta*, *Clossiana*, *Brenthis*). In the genera characterized by the flattened type of the occipital prominence, *Brenthis* differs from *Clossiana* and *Phalanta* in having the dorsal project of the intermediate plate. The values of W/H ratio (2. 1) and w/h ratio (2. 4) are almost the same as those of Melitaeinae. The ratio of w/W is 0. 44 and the value is biggest in Nymphalidae except in Charaxinae (Table 1). The sensory organ in the marginal furrow situates at its outer margin. In many species small setae and tubercles are absent or sparse.

1) *Phalanta*

P. phalantha (♂) (Photo 4, 65) The shape of the occipital prominence is characterized by belonging to the flattened type. The species has the smallest value of w/W ratio (0. 41). The ratio of F/d is larger (3. 4) than that in *Clossiana*. Small setae and tubercles are scattered in the outer part of the scale region. The occipital type is AA–P_1A.

2) *Clossiana*

C. iphigenia sachalinensis (♂) (Photo 66) The value of w/W (0. 42) is very small. The marginal furrow is narrowest (F/d=2. 0) as much as *Melitaea diamina regama*. Small setae and tubercles are absent. The occipital structure belongs to AA–AA type.

C. thore jezoensis (♂) (Photo 67) The fundamental structure resembles that of the former, though differing from it in the following points.

1. The dorsal part of occiput is wider (w/h=2. 7).

Table 2. Morphological characters of occipital region in Nymphalidae and

Species	W/H	w/W	w/h	F/d	Occipital type	Total density	Protub. of Opr.	Color of Opr. & Inp.
Nymphalidae								
Melitaeinae								
Melitaea scotosia	2.0	0.42	2.1	2.9	P_1A–AA	1	high	same
M. diamina regama	1.9	0.42	2.4	2.0	P_1P_1–AA	2	〃	〃
Mellicta athalia niphona	1.9	0.43	2.5	4.4	P_2P_1–P_2P_1	8	〃	〃
Argynninae								
Phalanta phalantha (♂)	2.1	0.41	2.0	3.4	AA–P_1A	1	high	differ.
Clossiana iphigenia sachalinensis (♂)	1.9	0.42	2.2	2.0	AA–AA	0	〃	〃
C. thore jezoensis (♂)	—	—	2.7	2.7	AA–P_1P_2	4	〃	〃
Brenthis daphne rabdia	2.0	0.45	2.4	2.9	P_1A–AA	1	〃	〃
B. ino tigroides	2.1	0.45	2.4	3.7	P_1A–AA	1	〃	〃
Argyronome laodice japonica	2.1	0.43	2.4	2.7	AA–AA	0	〃	〃
A. ruslana lysippe	2.1	0.43	2.5	3.2	AA–AA	0	〃	〃
Damora sagana ilona	2.1	0.43	2.5	3.3	P_1P_1–P_1A	3	〃	〃
Nephargynnis anadyomene midas	2.0	0.43	2.4	3.3	AA–AA	0	〃	〃
Argynnis paphia geisha	2.0	0.43	2.5	2.9	P_2A–AA	3	〃	〃
Speyeria aglaja fortuna	2.0	0.45	2.3	3.4	AA–AA	0	〃	〃
Fabriciana adippe pallescens	2.0	0.45	2.5	3.4	AA–AA	0	〃	〃
F. nerippe	2.1	0.45	2.4	3.2	AA–AA	0	〃	〃
Argyreus hyperbius	2.1	0.48	2.6	3.4	AA–AA	0	〃	〃
Limenitinae								
Athyma selenophora ishiana (♂)	1.8	0.36	1.6	3.7	P_3P_3–P_3A	15	high	same
Limenitis (Ladoga) glorifica	1.7	0.37	1.9	3.0	P_3P_2–P_2A	11	〃	〃
L. (L.) camilla japonica	1.8	0.34	1.5	2.9	P_3P_2–P_2A	11	〃	〃
L. populi jezoensis (♂)	1.7	0.40	2.1	4.5	P_3P_3–P_3A	15	〃	〃
Neptis sappho intermedia	1.8	0.33	1.5	3.0	P_1A–AP_1	2	〃	〃
N. hylas luculenta (♂)	—	—	—	2.4	P_2P_2–P_1P_2	10	〃	〃
N. philyra excellens	1.8	0.38	1.8	3.2	AA–AA	0	〃	〃
N. pryeri	1.8	0.32	1.5	2.9	P_1A–AP_1	2	〃	〃
N. alwina kaempferi	1.7	0.34	1.7	3.3	P_1P_1–AA	2	〃	〃
N. rivularis insularum	1.8	0.33	1.7	2.9	P_2A–AA	3	〃	〃
Nymphalinae								
Araschnia burejana strigosa	1.9	0.42	2.7	4.1	P_1P_2–P_2A	7	low	same

Libytheidae

Species	$\frac{W}{H}$	$\frac{w}{W}$	$\frac{w}{h}$	$\frac{F}{d}$	Occipital type	Total density	Protub. of Opr.	Color of Opr. & Inp.
A. levana obscura	1.9	0.42	2.7	4.4	P_1P_2–P_2A	7	low	same
Polygonia c-aureum	1.9	0.45	2.2	6.3	AP_2–AA	3	〃	〃
P. c-album hamigera	2.1	0.42	2.2	5.9	AP_2–P_1A	4	〃	〃
Nymphalis vau-album samurai	2.1	0.43	3.2	5.1	AP_2–P_2A	6	〃	〃
N. xanthomelas japonica	2.1	0.45	2.9	4.8	AP_1–AA	1	〃	〃
N. antiopa asopos	2.0	0.45	2.8	5.7	AA–P_2A	3	〃	〃
Kaniska canace no-japonicum	2.1	0.42	2.7	5.0	AP_1–P_1A	2	〃	〃
Inachis io geisha	2.1	0.45	2.8	4.9	AP_1–P_2A	4	〃	〃
Aglais urticae esakii	2.0	0.42	2.5	5.3	AP_1–P_2A	4	〃	〃
Cynthia cardui	2.3	0.42	2.8	4.1	AA–AA	0	〃	〃
Vanessa indica	2.3	0.40	2.8	3.8	AA–AA	0	〃	〃
Precis orithya (♂)	2.1	0.38	2.4	3.3	AA–AA	0	〃	〃
P. almana	2.0	0.40	2.3	3.9	P_1P_1–P_1A	3	〃	〃
Hypolimnas misippus	2.6	0.40	3.1	3.8	AA–AA	0	〃	〃
H. bolina kazia (♂)	2.3	0.40	3.0	3.8	P_1A–AA	1	〃	〃
Kallima inachus formosana	2.3	0.45	3.0	5.5	AP_1–AA	1	〃	〃
Yoma sabina vasuki (♀)	2.2	0.43	2.8	3.0	AA–AA	0	〃	〃
Apaturinae								
Hestina japonica	1.9	0.38	2.1	4.3	P_3P_2–P_2A	11	low	differ.
H. assimilis formosana (♂)	1.9	0.36	1.9	4.5	P_3P_2–P_2A	11	〃	〃
Sasakia charonda	2.0	0.38	2.2	4.1	P_3P_3–P_3A	15	〃	〃
Apatura ilia substituta	1.9	0.38	2.0	4.0	P_3P_2–P_3A	13	〃	〃
Dichorragia nesimachus nesiotes	1.8	0.37	2.0	2.5	P_1P_2–P_3P_3	14	high	differ.
Marpesiinae								
Cyrestis thyodamas formosana (♂)	1.8	0.29	1.5	4.6	P_1P_1–AA	2	low	differ.
Charaxinae								
Polyura eudamippus formosana	2.2	0.48	3.3	4.5	P_2A–AA	3	low	same
P. narcaea meghaduta (♂)	2.3	0.53	2.9	5.7	P_2A–AA	3	〃	differ.
Libytheidae								
Libythea celtis celtoides	2.5	0.40	2.9	2.3	P_3P_2–AA	8	low	same

2. The marginal furrow is larger (F/d=2.7).
3. Small tubercles are grown in the scale region. The occipital type is AA–P_1P_2.

3) *Brenthis*

B. daphne rabdia (Photo 5, 68) The marginal furrow is somewhat narrow (F/d=2.9). Network sutures are observed in the marginal furrow and in the scale region. Melanization of the occiput in the male is stronger than that in the female. In some individuals small tubercles are poor at the proximal part of the marginal furrow or at the distal part of the scale region. The main occipital type is P_1A–AA.

B. ino tigroides (Photo 6, 69) The occipital morphology is so similar to that of the former as it seems to be impossible to distinguish between them. The width of the marginal furrow is wider in this species (F/d=3.7) than in the former. Small tubercles are distributed poorly in the outer part of the marginal furrow. The occipital structure belongs to P_1A–AA type.

4) *Argyronome*

A. laodice japonica (Photo 7, 70) The occipital prominence takes a shape of long ellipse. This portion is melanized stronger in the male than in the female. The marginal furrow is narrow (F/d=2.7). Proximally running fine lines cover the marginal furrow and the scale region. No small setae and tubercles are seen. The occipital structure belongs to AA–AA type.

A. ruslana lysippe (Photo 8, 71) The occipital structure closely resembles that of the former except that the marginal furrow is wider (F/d=3.2). The occipital type is AA–AA.

5) *Damora*

D. sagana ilona (Photo 9, 55, 72) The dorsal part of the occipital prominence is slightly depressed. The female has a thicker occipital prominence than the male. Small tubercles are abundant in Argynninid species. The occipital structure belongs to P_1P_1–P_1A type.

6) *Nephargynnis*

N. anadyomene midas (Photo 10, 73) The ventral line of the occipital prominence curves harder than the dorsal line. The coloration of the prominence is darker in the male than in the female. The marginal furrow has no sutures. Small setae and tubercles are absent. The occipital type is AA–AA.

7) *Argynnis*

A. paphia geisha (Photo 11, 74) The shape of the occipital prominence varies in the dorsal part such as flat, protuberant or depressed. Proximally running line are found densely in the postocular plate. Small tubercles are grown in the outer part of the marginal furrow. In a few specimens they are scattered in the distal part of the scale region. The occipital type is considered to belong to P_2A–AA.

8) *Speyeria*

S. aglaja fortuna (Photo 12, 75) In the occipital prominence the dorsal line curves harder than the ventral line to the dorsal direction. By this character this species seems separable from the other butterflies in Argynninae. The ratio of w/h is as small as 2.3. The marginal furrow is wide (F/d=3.4). Both the marginal furrow and the scale region are covered with proximally running fine sutures but without small setae and tubercles. The occipital type is AA–AA.

9) *Fabriciana*

F. adippe pallescens (Photo 13, 76) The occipital prominence is more convexed in the male than in the female, the former taking darker coloration than the latter. The marginal furrow is wide (F/d=3.4). In some specimens small setae and tubercles are scattered. The main type of occipital structure is AA–AA.

F. nerippe (Photo 14, 77) The dorsal and ventral margins of the occipital prominence are concave. The prominence is yellowish brown in color. This species differs from the others in these points. In the marginal furrow network sutures are found but not small setae and tubercles. The occipital type is AA–AA.

10) *Argyreus*

A. hyperbius (Photo 15, 78) The dorsal curve of the occipital prominence is gentle. Both the ratios of w/h (2.6) and w/W (0.48) are biggest. The marginal furrow is wide (F/d=3.4), in which fine sutures run proximally. Small setae and tubercles are absent. The occipital structure belongs to AA–AA type.

3. Limenitinae

The occipital prominence protrudes more posteriorly (Photo 56) than that of Melitaeinae (Photo 54) and Argynninae (Photo 55). The intermediate plate is melanized as much as the occipital prominence. The dorsal part of occiput takes dark brown or black except that of *Athyma selenophora ishiana* which is brown. The dorsal tip of the postocular plate generally becomes sharp. *Limenitis* is different from the other genera in the structure of the occipital prominence and the postocciput, and F/d ratio. The width of the head is narrowest (W/H=1.8), and the values of w/h ratio (1.7) and w/W ratio (0.35) are smallest except for Marpesiinae in Nymphalidae (Table 1).

In *Neptis* the dorsal end of the intermediate plate doesn't project. The occipital prominence is characterized by the posteriorly oblique protrusion. Not so much small setae and tubercles are found with exception of *N. hylas lucullenta*. Meanwhile in *Limenitis*, *Athyma* and *Ladoga*, the dorsal end of the intermediate plate projects dorsally, and the occipital prominence is roundish. Small setae and tubercles are abundant. The occipital type is uniformly PP–PA in these three genera. The sensory organ lies at the outer part of the marginal furrow.

1) *Athyma*

A. selenophora ishana (♂) (Photo 16, 79) The ventral curve of the occipital prominence is much stronger than the dorsal one. The marginal furrow is rather wider (F/d=3. 7) than that of *Ladoga* and *Neptis*. A lot of small setae and tubercles are grown over the marginal furrow and the outer part of the scale region. The occipital type is P_3P_3–P_3A.

2) *Limenitis*

L. (*Ladoga*) *glorifica* (Photo 17, 80) The value of w/W ratio (0. 37) is a little big. The melanization is stronger in the male than in the female. Sutures are scarcely seen in the postocular plate. Small setae and tubercles are considerably rich. The occipital structure belongs to P_3P_2–P_2A type.

L. (*Ladoga*) *camilla japonica* (Photo 18, 81) The occipital morphology resembles that of *glorifica*. The occipital type is P_3P_2–P_2A. The following points are different from the above species, however.

1. The dorsal curvature is more convexed.
2. The value of w/W ratio (0. 34) is somewhat small.

L. populi jezoensis (♂) (Photo 19, 82) The occipital prominence is situated at the more dorsal position and the dorsal part of the postocular plate doesn't project so sharply, as compared with the other butterflies of Limenitinae. The postocciput bends significantly towards the dorsal direction. The values of w/h ratio (2. 1) and w/W one (0. 40) are biggest. The marginal furrow is much wider (F/d=4. 5) than that of any other species. Small setae and tubercles are numerous. The occipital type belongs to P_3P_3–P_3A.

3) *Neptis*

N. sappho intermedia (Photo 20, 83) The dorsal margin of the occipital prominence is almost straight. The ratio of w/h (1. 5) is smallest in Nymphalidae. The value of w/W ratio (0. 33) is very small. The coloration of the occiput is darker in the female than in the male. Tubercles are poor and small setae are absent. The occipital type belongs to P_1A–AP_1.

N. hylas luculenta (♂) (Photo 84) The marginal furrow is narrowest (F/d=

2, 4). A considerable number of small setae and tubercles are distributed over the postocular plate, though they are generally poor in *Neptis*. The occipital structure belongs to P_2P_2–P_1P_2 type.

N. philyra excellens (Photo 21, 56, 85) The dorsal margin of the occipital prominence curves gently. The occiput is melanized strongly. The ratio of w/W (0. 38) is large. Though small setae and tubercles are grown poorly at the outer part of the scale region in some individuals, the main occipital type is AA–AA.

N. pryeri (Photo 22, 86) The ratio of w/W (0. 32) is smallest except for *Cyrestis* in Nymphalidae. The occipital type is P_1A–AP_1. The occipital structure is similar to that of *N. sappho intermedia* except for the following points.

1. The curvature of the dorsal margin of the occipital prominence is gentle.
2. Melanization is stronger in the male than in the female.
3. The marginal furrow is covered with fine sutures and networks, and scale region with big and deep sutures running proximally.

N. alwina kaempferi (Photo 23, 87) The dorsal margin of the occipital prominence is most convexed in *Neptis*. The marginal furrow is widest (F/d= 3. 3) in this genus. The melanization of the occiput is stronger in the male than in the female. Sutures covering the postocular plate closely resemble those of the above species. Small tubercles are scattered only in the marginal furrow. The occipital structure belongs to P_1P_1–AA type.

N. rivularis insularum (Photo 24, 88) The occipital structure resembles that of *N. sappho intermedia*, but the following points are different.

1. The dorsal margin of the occipital prominence curves gently.
2. The ratio of w/h (1. 7) is slightly bigger.
3. Coloration of the occiput is darker in the male than in the female.
4. The occipital type is P_2A–AA.

4. Nymphalinae

The occipital prominence protrudes weakly. There is not so much difference in melanization between the occipital prominence and the intermediate plate. The postocciput is higher posteriorly than the prominence (Photo 57). This subfamily is divisible into two groups by the shapes of the postocular plate and the postocciput. The one is characterized by a strong protuberance (Photo 57) and the other by a weak one (Photo 58). The former contains such genera as *Araschnia*, *Polygonia*, *Nymphalis*, *Kaniska*, *Inachis*, *Aglais*, *Cynthia* and *Vanessa*. The latter includes four genera such as *Precis*, *Hypolimnas*, *Kallima* and *Yoma*. The occiput of *Precis* is darkest in the second group. The characters of the occiput varies very much according to genus or species as follows.

The ratios of W/H, w/h and F/d are 1.9～2.6, 2.2～3.2 and 3.0～6.3, respectively. The occipital type belongs to AA–AA～PP–PA. The total density varies 0～7 (Table 2).

1) *Araschnia*

A. burejana strigosa (Photo 25, 89) The ratio of W/H (1.9) is smallest. The marginal furrow is narrow (F/d=4.1). Small setae and tubercles are richest. The occipital type is P_1P_2–P_2A.

A. levana obscura (Photo 26, 90) The occipital structure belongs to P_1P_2–P_2A type. The occipital morphology is closely similar to that of the former except that the occipital prominence is rounder.

2) *Polygonia*

P. c-aureum (Photo 27, 91) The occipital prominence is roundish. The values of W/H ratio (1.9) and w/h ratio (2.2) are smallest. The marginal furrow is widest (F/d=6.3) in Nymphalidae. The occiput is melanized darkly, especially in the male. Tubercles are scattered in the inner part of the marginal furrow. The occipital type is AP_2–AA.

P. c-album hamigera (Photo 28, 92) The occipital structure is different from the above species in the following points.

1. The occipital prominence is not so roundish as in *c-aureum.*
2. The distal part of the scale region is covered with complex sutures.
3. The marginal furrow is narrower (F/d=5.9).
4. The coloration of the occiput is weaker.
5. Small setae and tubercles are found not only in the inner part of the marginal furrow but also in the outer part of the scale region. The occipital structure belongs to AP_2–P_1A type.

3) *Nymphalis*

N. vau-album samurai (Photo 29, 93) The dorsal end of the intermediate plate is rather sharp. The occipital prominence makes a flat reversed V-shape. Small setae and tubercles are fairly rich in the inner part of the marginal furrow and the outer part of the scale region. The occipital type is AP_2–P_2A.

N. xanthomelas japonica (Photo 30, 57, 94) The intermediate plate has the dorsal end which is not sharply protruded. The dorsal margin of the occipital prominence is somewhat roundish. The occiput is melanized weakly. Network sutures are observed in the inner part of the marginal furrow and also in the outer part of the scale region. Tubercles are poor in the marginal furrow. The occipital structure belongs to AP_1–AA type.

N. antiopa asopos (Photo 31, 95) The occipital structure resembles that of the previous species except in the following points.

1. The dorsal margin of the occipital prominence forms a flat reversed V-shape.
2. Only the outer part of the scale region bears tubercles. The occipital type is AA–P_2A.
3. The marginal furrow is much wider (F/d=5. 7).

4) *Kaniska*

K. canace no-japonicum (Photo 32, 96) The occipital structure is similar to that of *N. vau-album samurai*, but the following points are different.

1. The occiput is melanized weakly except for its dorsal part.
2. The coloration of the occiput is darker in the female than in the male.
3. The outer part of the scale region with tubercles is covered with network sutures.
4. Tubercles are poorer. The occipital structure belongs to AP_1–P_1A type.

5) *Inachis*

I. io geisha (Photo 33, 97) The occipital prominence protrudes roundly. The coloration of the occiput is darker in the male than in the female, though the dorsal part of occiput takes dark coloration regardless of sex. The marginal furrow bears network sutures with fine sutures. Small setae and tubercles are grown in the proximal part of the furrow and in the distal part of the scale region. The occipital type is AP_1–P_2A.

6) *Aglais*

A. urticae esakii (Photo 34, 98) The dorsal end of the intermediate plate becomes sharp. The occiput is dark brown in color. Network sutures are found in the marginal furrow. The inner part of the marginal furrow and the outer margin of the scale region have sparse small setae and tubercles as same as in the previous species. The occipital structure belongs to AP_1–P_2A type.

7) *Cynthia*

C. cardui (Photo 35, 99) The intermediate plate is characterized by an evidently sharpened dorsal end. The occipital prominence protrudes weakly towards the dorsal direction. The occiput is wide (W/H=2. 3). The marginal furrow is considerably narrow (F/d=4. 1). Small setae and tubercles are absent. The occipital type is AA–AA.

8) *Vanessa*

V. indica (Photo 36, 100) The occipital structure is closely related to that of *Cynthia cardui*. The occipital type is AA–AA. The following points are different from the former.

1. The dorsal end of the intermediate plate is not so sharpened.
2. The marginal furrow is narrower (F/d=3. 8).

9) *Precis*

P. orithya (♂) (Photo 37, 101) The value of w/W ratio (0. 38) is smallest. The marginal furrow is narrow (F/d=3. 3). Radial sutures are found at the root of scale. No small setae and tubercles are observed. The occipital structure belongs to AA–AA type.

P. almana (Photo 38, 102) The occipital structure resembles that of *orithya* except for the following points.

1. The marginal furrow is wider (F/d=3. 9).
2. Tubercles are scattered.
3. The occipital type is P_1P_1–P_1A.

10) *Hypolimnas*

H. misippus (Photo 39, 103) The width of the occiput is largest in Nymphalidae (W/H=2. 6), and that of the dorsal part is considerably wide (w/h=3. 1). The marginal furrow is narrow (F/d=3. 8). The occipital structure belongs to AA–AA type.

H. bolina kazia (♂) (Photo 40, 104) The followings are different from the previous species.

1. The coloration of the occiput is weaker.
2. The occiput and its dorsal part are narrower (W/H=2. 3, w/h=3. 0).
3. The marginal furrow bears tubercles poorly.
4. The occipital type is P_1A–AA.

11) *Kallima*

K. inachus formosana (Photo 41, 105) The dorsal margin is parallel to the ventral one in the occipital prominence. The occiput is yellow. The intermediate plate develops deeply towards the ventral direction. The ventral tip of the postocular plate projects sharply. The width of the occiput is big (W/H=2. 3). A small amount of tubercles are grown in the inner part of the marginal furrow. The occipital structure belongs to AP_1–AA type.

12) *Yoma*

Y. sabina vasuki (♀) (Photo 42, 106) In this species melanization of the intermediate plate is stronger than in the occipital prominence, differing from the other species in Nymphalidae except for *Polyura narcaea meghaduta.* The postocular plate is yellowish brown. The occipital prominence has a similar shape to that of the previous species. The marginal furrow is narrowest (F/d=3. 0). Small setae and tubercles are absent. The occipital type is AA–AA.

5. Apaturinae

The occipital prominence protrudes very gently (a). Its center and the dorsal end of the intermediate plate protrude towards the dorsal direction. The occiput takes blackish coloration with exception of the intermediate plate, which is yellowish brown. The connection part conjoins very smoothly with the occipital prominence (b). The above (a) and (b) are different characters from Argynninae. The ratio of w/W (0. 38) is small. The marginal furrow is rather wide (F/d=4. 1, Table 1). The sensory organ is situated at the inner part of the marginal furrow (Photo 109). Small setae and tubercles are grown densely in the marginal furrow and in the outer part of the scale region. The occipital type of all species is uniformly PP–PA.

1) *Hestina*

H. japonica (Photo 43, 107) The color of the occiput is darker in the male than in the female. The values of w/W ratio and w/h ratio are 0. 38 and 2. 1, respectively. It is 4. 3 in F/d ratio. Small setae and tubercles are densely grown in the marginal furrow and in the outer part of the scale region. The occipital type is P_3P_2–P_2A.

H. assimilis formosana (♂) (Photo 44, 108) The occipital structure belongs to P_3P_2–P_2A type. It resembles closely that of the former except for the following points.

1. The ratios of w/W (0. 36) and w/h (1. 9) are slightly smaller.
2. The marginal furrow is a little wider (F/d=4. 5).

2) *Sasakia*

S. charonda (Photo 45, 109) The center of the occipital prominence protrudes slightly to the dorsal direction. The prominence is easily distinguishable from the intermediate plate by coloration. Melanization of the intermediate plate is weakest. The ventral tip of the postocular plate projects sharply. A great number of small setae and tubercles are found in the marginal furrow and in the outer part of the scale region. The occipital type is P_3P_3–P_3A.

3) *Apatura*

A. ilia substituta (Photo 46, 110) The occipital characters are closely related to those of *Hestina*, though the following differences are detectable.

1. The marginal furrow is narrower (F/d=4. 0).
2. The occipital structure belongs to P_3P_2–P_3A type.

4) *Dichorragia**

D. nesimachus nesiotes (Photo 47, 59, 111) The occipital structure is different from that of Apaturinae in the following points.

1. The occipital prominene protoudes significantly.
2. The depressed connection part and intermediate plate make a U–shaped

* The genus was excluded from Apaturinae by SHIRÔZU (1960), though its taxonomic position unknown yet.

furrow.

3. The marginal furrow is much narrower (F/d=2. 5).
4. Small setae and tubercles are distributed widely over postocular plate.
5. The coloration of the occiput is fairly weaker.
6. The occipital type is P_1P_2–P_3P_3.

6. Marpesiinae

1) *Cyrestis*

C. thyodamas formosana (♂) (Photo 48, 112) The occipital prominence protrudes so weakly that indistinguishable from the intermediate plate except for the coloration, which is black in the former and is brown in the latter. The ratio of W/H (1. 8) is very small. Besides the values of w/h ratio (1. 5) and w/W ratio (0. 29) are smallest in Nymphalidae. The marginal furrow is a little wide (F/d=4. 6), in which are found network sutures. Small setae are scattered in the marginal furrow. The occipital type is P_1P_1–AA.

7) Charaxinae

The structures of the occipital region differ evidently from those of the other subfamilies in the following points.

1. The occipital prominence is divided into two parts.
2. The intermediate plate forms a V-shape.
3. The postocciput develops markedly in the form of a triangle to insert nearly between the occipital prominences.
4. The connection part is absent.
5. The ratio of w/W (0. 51) is bigger.

Whole occipital region is melanized weakly. The sensory organ lies at the center of the marginal furrow. Small setae and tubercles are found only in the outer part of the marginal furrow. The occipital structure belongs to PA–AA type.

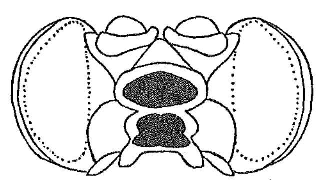
Fig. 2. Occipital region of Charaxinae.

1) *Polyura*

P. eudamippus formosana (Photo 49, 60, 113) The occiput takes yellowish brown coloration except at the center of the postocciput and the peripheral part of the postocular plate, which are dark brown. The marginal furrow is somewhat wide (F/d=4. 5). In its inner part network sutures are found. Small setae and tubercles are distributed in the outer part of the marginal furrow. The occipital type is P_2A–AA.

The occipital structure of *P. narcaea meghaduta* (Photo 50, 114) from Formosa resembles that of *P. eudamippus formosana* with exception of the following points.

1. The ratios of w/W (0. 53) and F/d (5. 7) are larger.
2. The value of w/h ratio (2. 9) is smaller.
3. The melanization is stronger.
4. Proximally running sutures are denser in the scale region.

B. LIBYTHEIDAE

1. *Libythea*

L. celtis celtoides (Photo 51, 61, 115) The structure of the occipital region resembles that of Nymphalidae as a whole. The following points are different, however.

1. The occipital prominence protrudes too weakly to be clearly separated from the intermediate plate.
2. Near ventral part of the postocular plate three processes are seen from back aspect of head.
3. A swollened part of the postocular plate lies more ventrally.

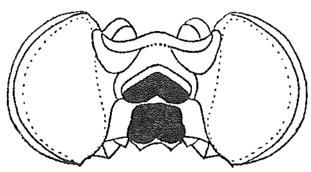

Fig. 3. Occipital region of Libytheidae.

The occiput and its dorsal part is very wide (W/H=2. 5, w/h=2. 9). The marginal furrow is narrow (F/d=2. 3). Both the occipital prominence and the intermediate plate take blackish coloration. Many fine complicated sutures are observed at the scale region. Small setae are found only at the marginal furrow. The occipital type is P_3P_2–AA.

V. PHYLOGENICAL GROUPING OF NYMPHALIDAE BASED ON THE OCCIPITAL STRUCTURE

As mentioned above, morphological characters of the occipital region vary considerably according to group or species. Further the head capsule is, so to speak, a container of the central nervous system which relates to the sensory organs, viz. compound eye, antenna, etc. acting as a forerunner of recognition of the species. They can, therefore, be used as diagnostic indicator of butterflies. Morphological characters of the occipital region in each subfamily and species are shown in Table 1～2. The authors want to approach to a taxonomic revision of Japanese Nymphalidae, using morphological characters of the occipital region for phylogenical consideration

Generally in Nymphalidae the dorsal part of occiput consists of the undivided occipital prominence, the intermediate plate and the connection part. But in Charaxinae its structure is quite different from that in the other Nymphalid subfamilies and also in Satyridae (Photo 52, 116) and Danaidae (Photo 53, 117). Namely the occipital prominence is divided into two parts and the postocciput develops remarkably in the form of a triangle to insert nearly between the both occipital prominences. Then the intermediate plate makes a V-shape and the connection part is absent. Considering from these special characters, Charaxinae will be separable from Nymphalidae to set up newly "Charaxidae". The other subfamilies are divided into two groups based on the grade of protuberance of the occipital prominence.

Group I The occipital prominence protrudes extremely and is separated clearly from the other parts. This group contains three subfamilies and one genus, viz. Argynninae, Melitaeinae, Limenitinae and *Dichorragia*. Further it is divided into two subgroups according to the coloration of the occipital prominence and the intermediate plate.

Subgroup 1 The coloration of the intermediate plate is evidently different from that of the occipital prominence. Argynninae and *Dichorragia* belong to this subgroup. Argynninae is divisible into two. One has the reversed trapezoid occipital prominence. The other has the roundish one. The former contains *Brenthis*, *Clossiana* and *Phalanta*, and the latter the other genera. In the former *Brenthis*, whose dorsal end of intermediate plate projects, is separable from *Clossiana* and *Phalanta*. In the latter the occipital structure resembles one another, and individual variation is seen in many species. Therefore, it is difficult to group them from the viewpoint of the occipital morphology. According to KOYAMA and MIYATA (1969) it is said that the density of small setae and tubercles contribute to evolutional meaning, as AA-AA type most evolved and PP-PP type most primitive. In Argynninae, small setae and tubercles are absent or very poor. It means this subfamily is evolved.

In *Dichorragia nesimachus nesiotes* the dorsal part of the connection part as well as the intermediate plate are depressed and they make yellowish brown U-shaped furrow.

Besides numerous small setae and tubercles are widely distributed. The occipital type is P_1P_2-P_3P_3. This species was previously included in the subfamily Apaturinae, but SHIRÔZU (1960) pointed out that its taxonomic position was considerably far from the subfamily Apaturinae mainly based on genitalian structure. And FUKUDA and TANAKA (1968) stated that there were many primitive characters in the ecology of the larva and the adult of this species. The occipital morphology is also agreed with their opinions. It seems to be adequate to set up a new subfamily for the genus *Dichorragia*.

Subgroup 2 The intermediate plate is melanized as same as the occipital prominence. This subgroup includes two subfamilies of Limenitinae and Melitaeinae. In Limenitinae the genus *Limenitis* is independent from the other genera based on the structure of the dorsal part of occiput. KAWAZOE and WAKABAYASHI (1976) proposed that there was no need to separate the subgenus *Ladoga* from *Liminitis*. It is, however, desirable to treat them as the respective genus considered through the occipital morphology.

The genus *Neptis* is different from the other genera in the shape of the occipital prominence and the intermediate plate. As poor or no small setae and tubercles are scattered in almost all species, *Neptis* is thought as a fairly evolved group. Meanwhile *Ladoga*, *Athyma* and *Limenitis* have a lot of small setae and tubercles, and they belong to PP–PA type. They seem to stand at a very primitive position.

In Melitaeinae the two genera, *Melitaea* and *Mellicta*, are similar to each other. There are, however, differences in the occipital type and the width of the marginal furrow. *Melicta* is considered to be more primitive than *Melitaea*.

Group II The occipital prominence protrudes very poorly or scarcely. Nymphalinae, Apaturinae, and Marpesiinae belong to Group II. It is divided into two subgroups according to the coloration of the occipital prominence and the intermediate plate.

Subgroup 3 The coloration of the occipital prominence clearly differs from that of intermediate plate. This subgroup includes Apaturinae and Marpesiinae.

In Apaturinae each genus has a close relationship in the occipital morphology, belonging to the same type of PP–PA. This subfamily seems very primitive.

Marpesiinae is far different from the other subfamilies in the values of w/W and w/h ratio and the occipital type except for *Neptis alwina kaempferi*.

Subgroup 4 There is not so much difference between melanizations of the occipital prominence and the intermediate plate. Nymphalinae belongs to this subgroup. It is divisible into two groups. The one has a very protruded postocular plate and postocciput, and the other is provided with a weakly protuberant ones. Judging from the occipital type and the total density the first group is more primitive than the second. Especially the genus *Araschnia* is most primitive. The two genera, *Vanessa* and *Cynthia*, are characterized by a sharp dorsal end of the intermediate plate, a large W/H ratio and the occipital type of AA–AA, which means they are very evolved. Besides they are so similar to each other in the occipital morphology that unable to treat them as the different genus. Comparing the occipital morphology of *Nymphalis* with that of *Polygonia*, the former has much bigger w/h ratio. Therefore, it is reasonable that *vau-album samurai* was put into *Nymphalis* from *Polygonia*.

In the first group there are small differences among genera, and it seems difficult to separate each genus clearly from the others except for *Araschnia*, *Vanessa* and *Cynthia*.

In the second group *Precis* is different from the others in melanization, W/H ratio and w/h one. *Kallima* and *Yoma* are separable from *Hypolimnas* by the shape of the occipital prominence. The former is characterized by the ventrally developed intermediate plate.

Consequently the phylogenical arrangement based on the occipital morphology will be summarized as in Fig. 4.

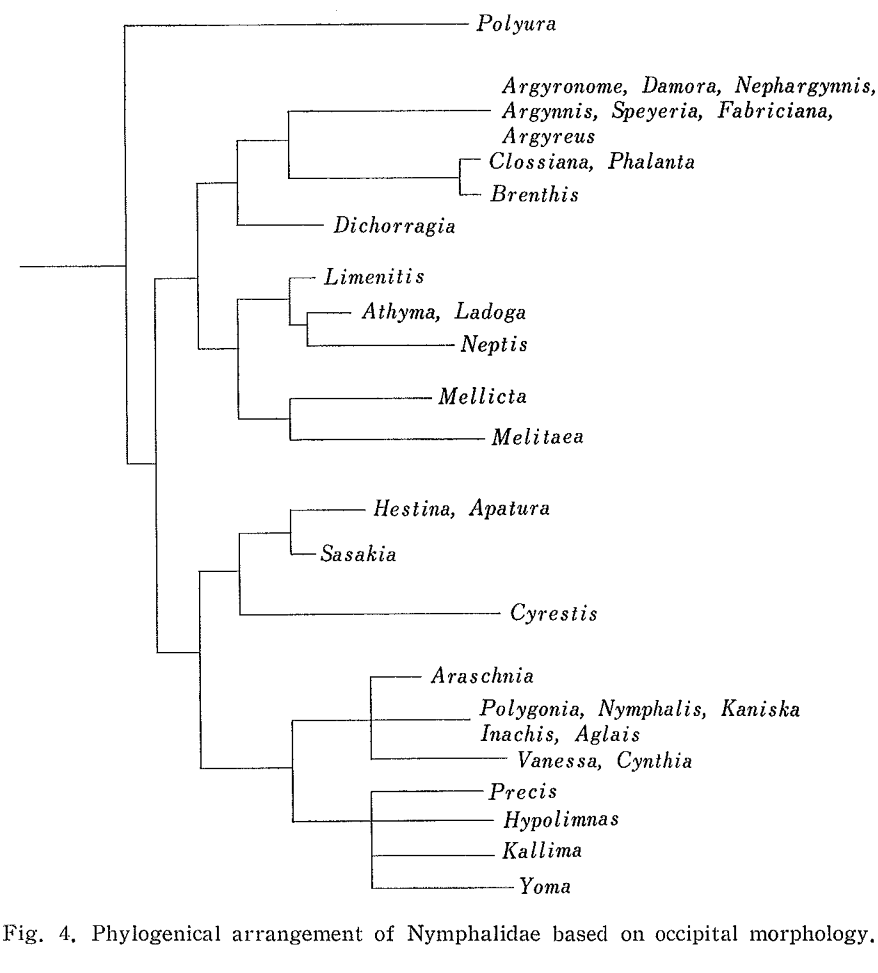

Fig. 4. Phylogenical arrangement of Nymphalidae based on occipital morphology.

VI. SUMMARY

The occipital morphology of 54 species belonging to Nymphalidae and Libytheidae was studied with reference to its bearing on phylogenical grouping.

1. The occipital region consists of three main parts, viz. dorsal part of occiput, postocular plate and occipital foramen. Further the dorsal part of occiput is divisible into occipital prominence, intermediate plate and connection part, and postocular plate into marginal furrow, scale region and basal part of occiput.

2. Libytheidae is distinguished from Nymphalidae by main three characters.

3. The occipital morphology in Charaxinae is greatly different from that of the other subfamilies in Nymphalidae. It seems suitable to separate Charaxinae from Nymphalidae.

4. The occipital morphology in *Dichorragia nesimachus nesiotes* differs from that of Apaturinae markedly.

5. In the genus *Limenitis*, *L. populi* is very different from *L. glorifica* and *L. camilla* in the occipital morphology, and so it is inacceptable to treat them as one genus.

6. *Vanessa indica* and *Cynthia cardui* are so similar to each other in the occipital morphology that it is unable to treat them as the different genus.

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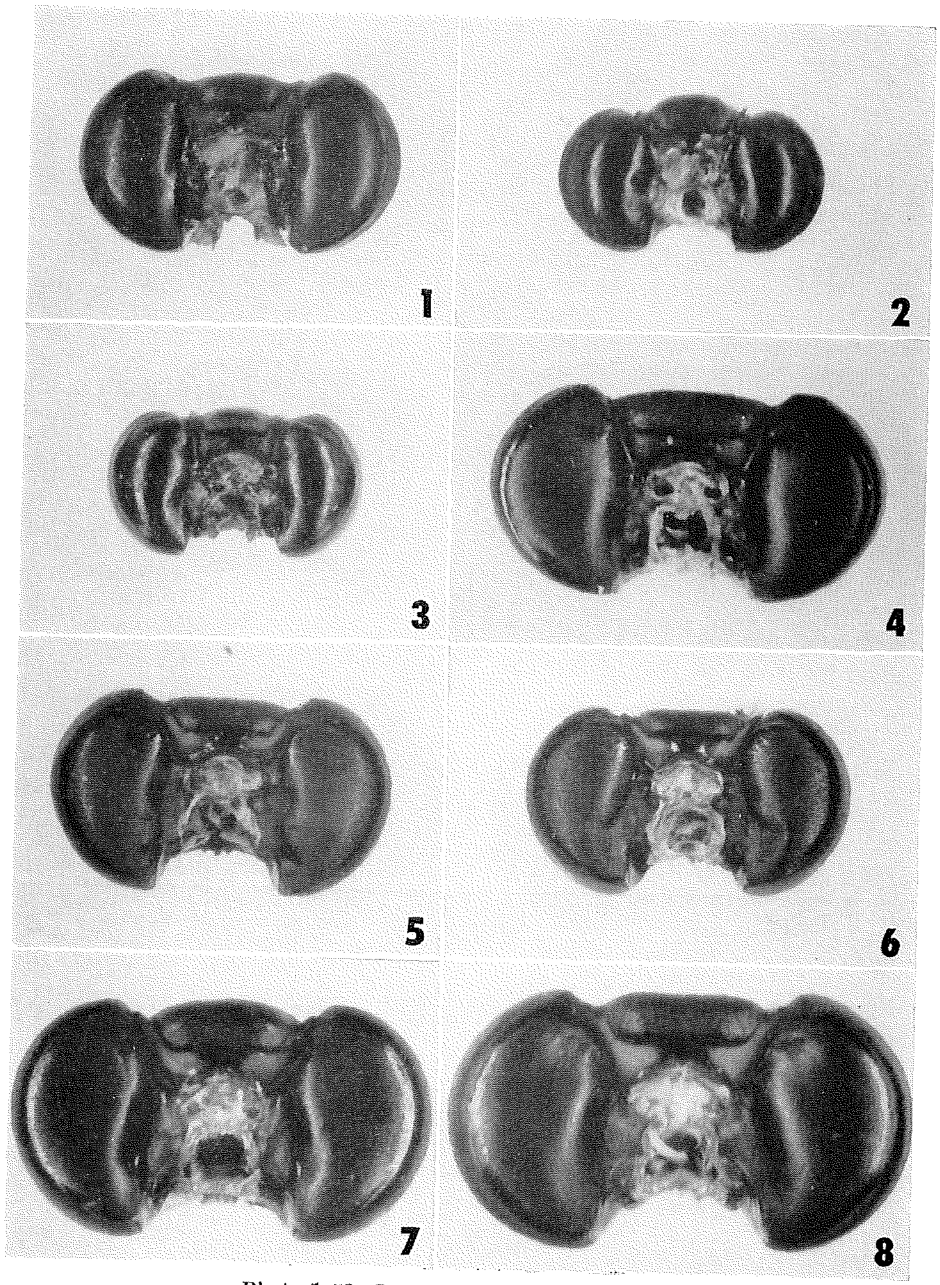
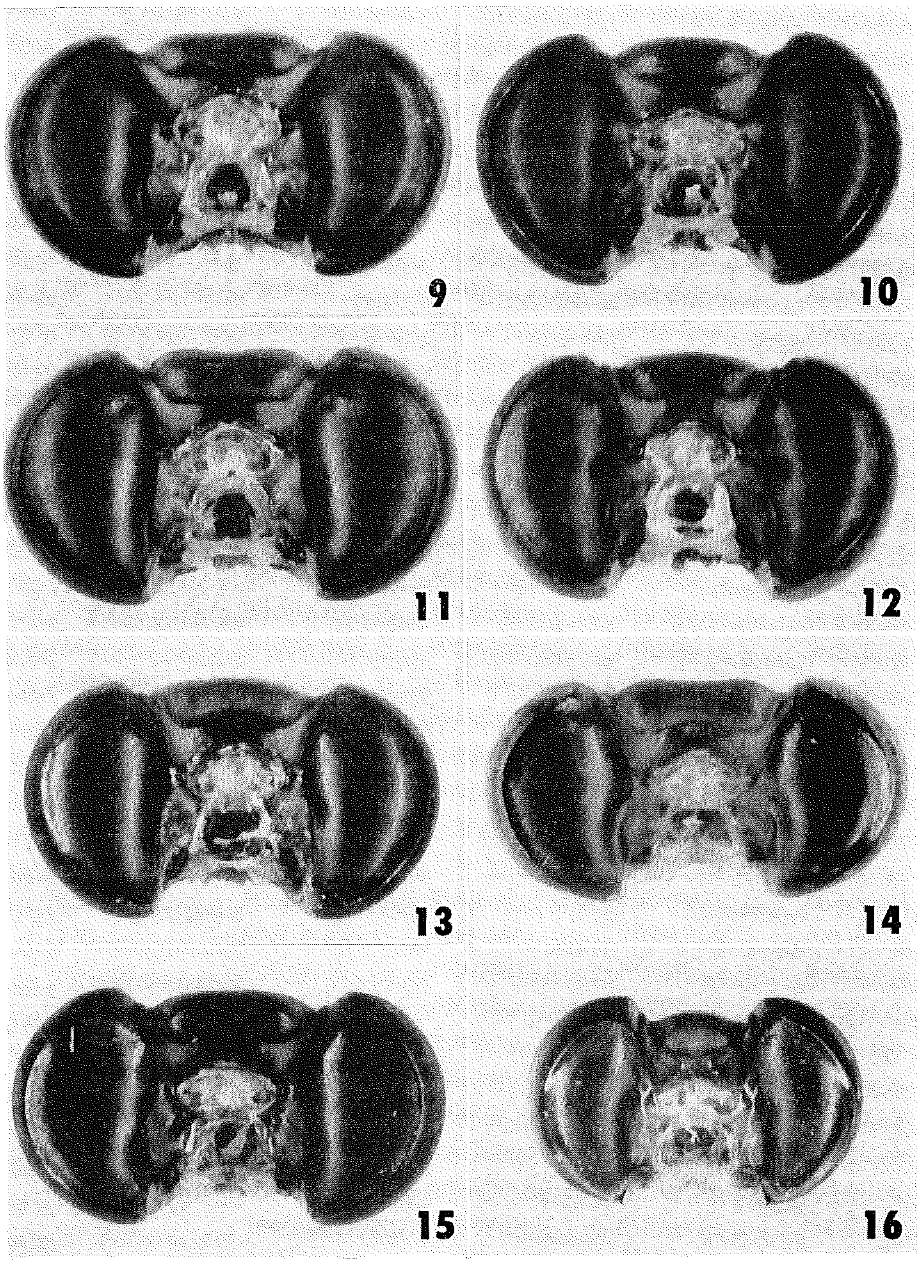
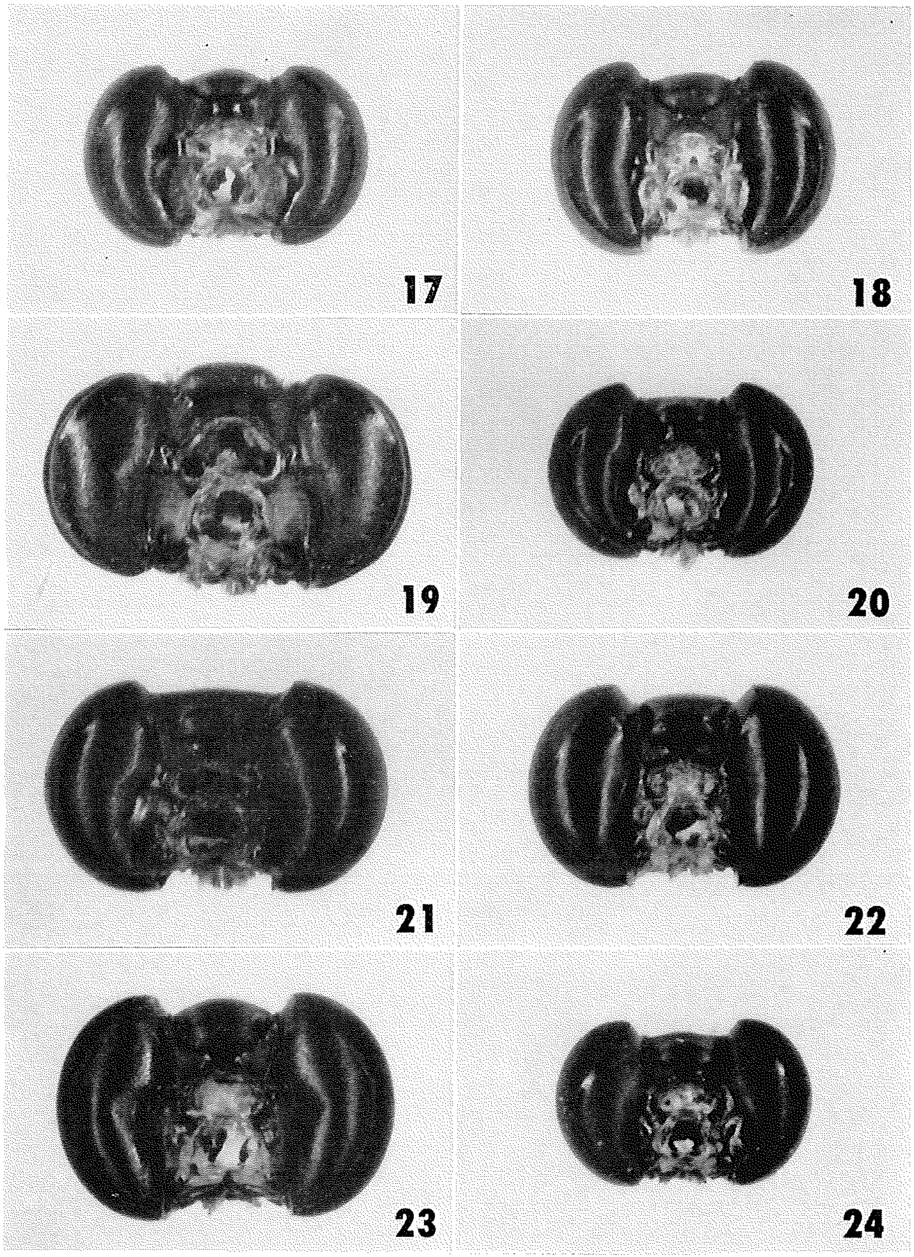


Photo 1-53. Posterior view of head(×10)

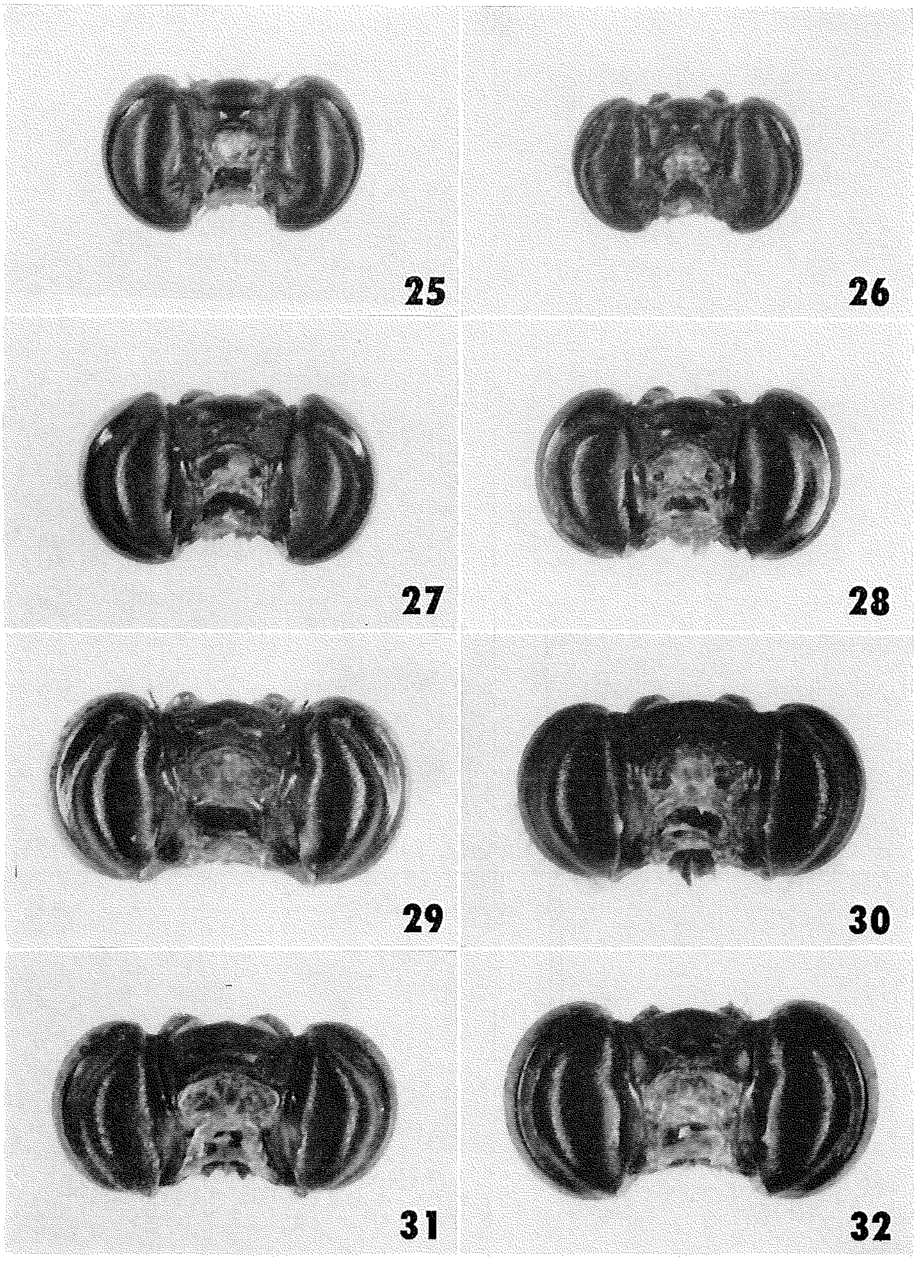
1. *Melitaea scotosia*
2. *M. diamina*
3. *Mellicta athalia*
4. *Phalanta phalantha*
5. *Brenthis daphne*
6. *B. into*
7. *Argyronome laodice*
8. *A. ruslana*



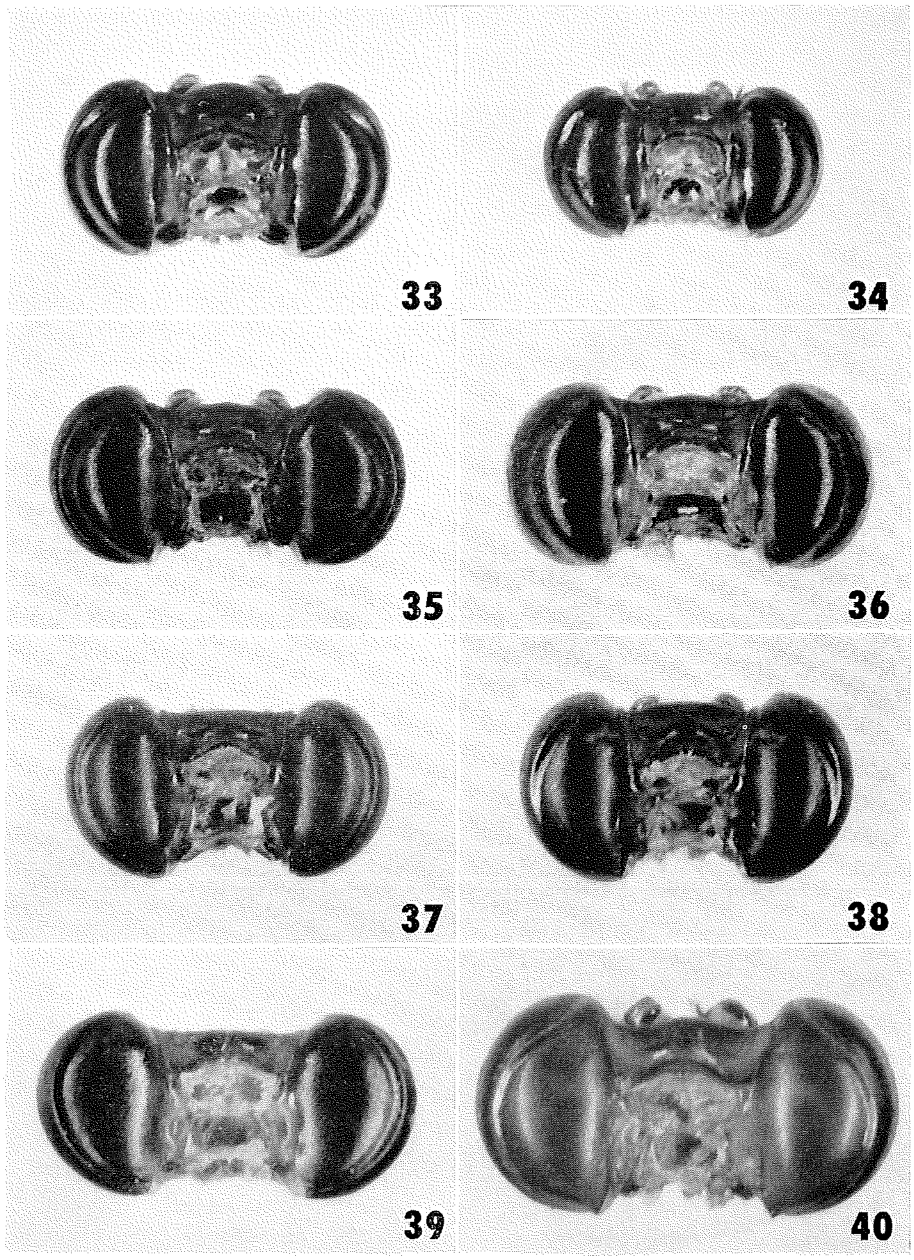
9.	*Damora sagana*	10.	*Nephargynnis anadyomene*
11.	*Argynnis paphia*	12.	*Speyeria aglaja*
13.	*Fabriciana adippe*	14.	*F. nerippe*
15.	*Argyreus hyperbius*	16.	*Athyma selenophora*



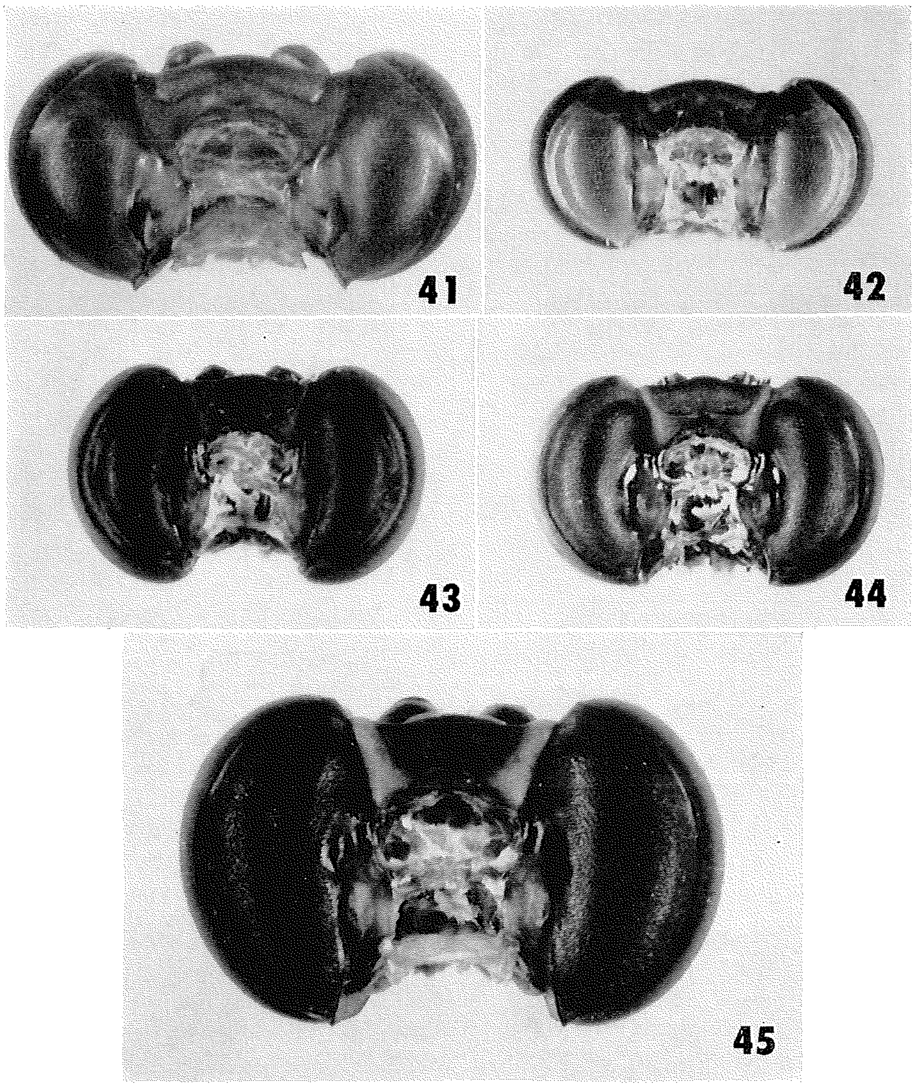
17. *Ladoga glorifica* 18. *L. camilla*
19. *Limenitis populi* 20. *Neptis sappho*
21. *N. philyra* 22. *N. pryeri*
23. *N. alwina* 24. *N. rivularis*



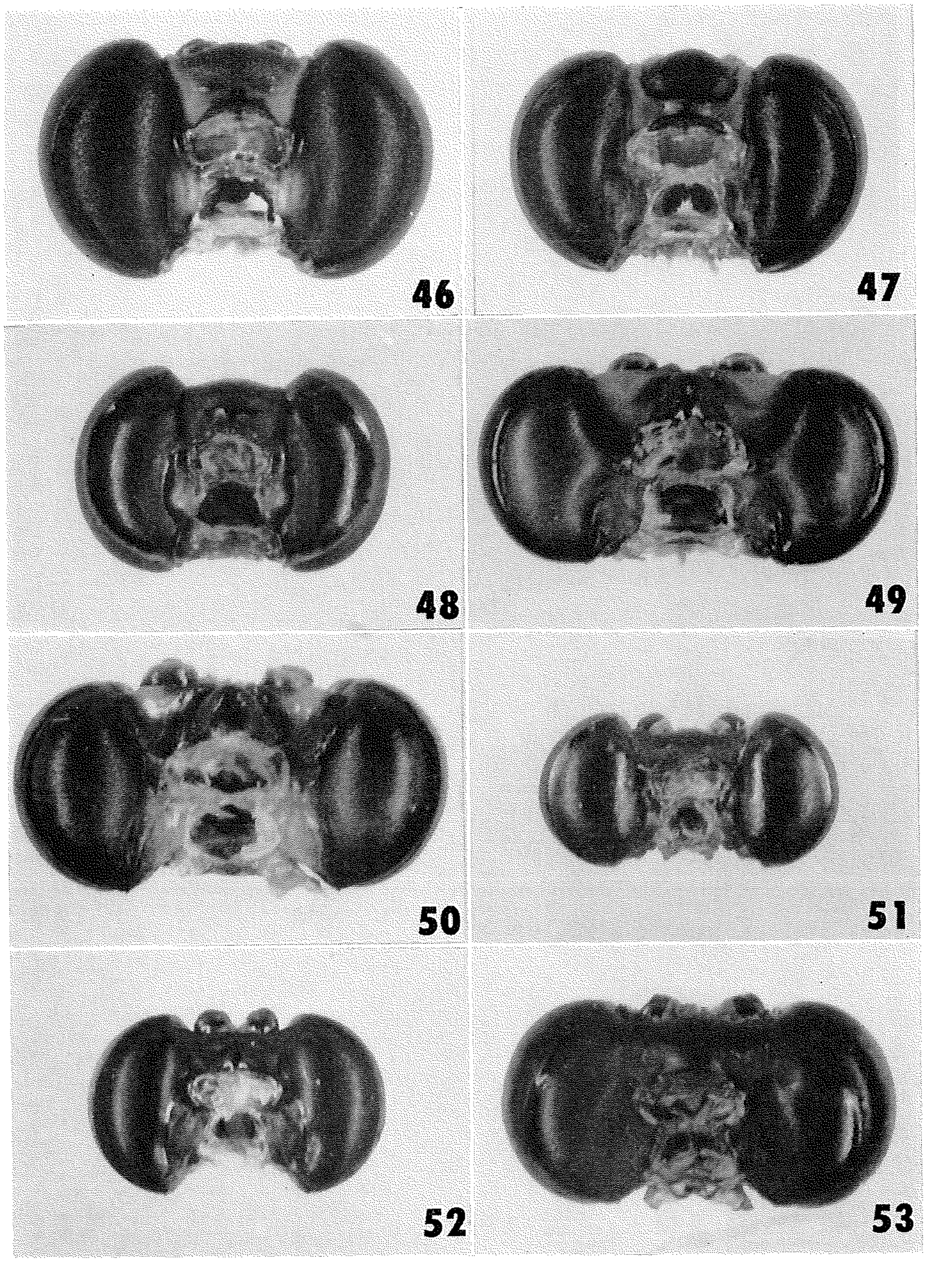
25. *Araschnia burejana* 26. *A. levana*
27. *Polygonia c-aureum* 28. *P. c-album*
29. *Nymphalis vau-album* 30. *N. xanthomelas*
31. *N. antiopa* 32. *Kaniska canace*



33. *Inachis io* 34. *Aglais urticae*
35. *Cynthia cardui* 36. *Vanessa indica*
37. *Precis orithya* 38. *P. almana*
39. *Hypolimnas misippus* 40. *H. bolina*



41. *Kallima inachus* 42. *Yoma sabina*
43. *Hestina japonica* 44. *H. assimilis*
45. *Sasakia charonda*



46. *Apatura ilia*
47. *Dichorragia nesimachus*
48. *Cyrestis thyodamas*
49. *Polyura eudamippus*
50. *P. narcaea*
51. *Libythea celtis*
52. *Lethe diana* (Satyridae)
53. *Parantica sita* (Danaidae)

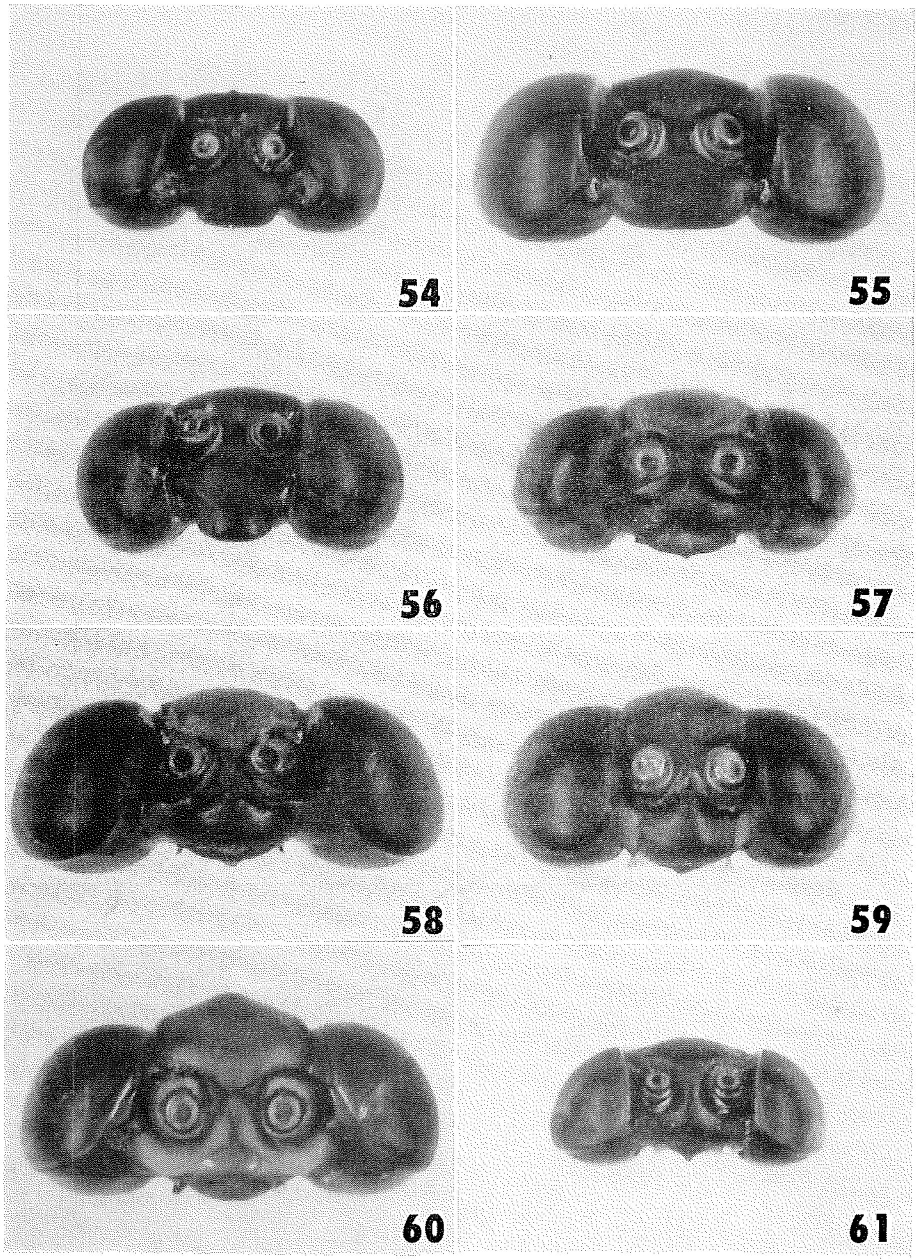


Photo 54–61. Dorsal view of head(×10)

54. *Melitaea scotosia*
55. *Damora sagana*
56. *Neptis philyra*
57. *Nymphalis xanthomelas*
58. *Hypolimnas bolina*
59. *Dichorragia nesimachus*
60. *Polyura eudamippus*
61. *Libythea celtis*

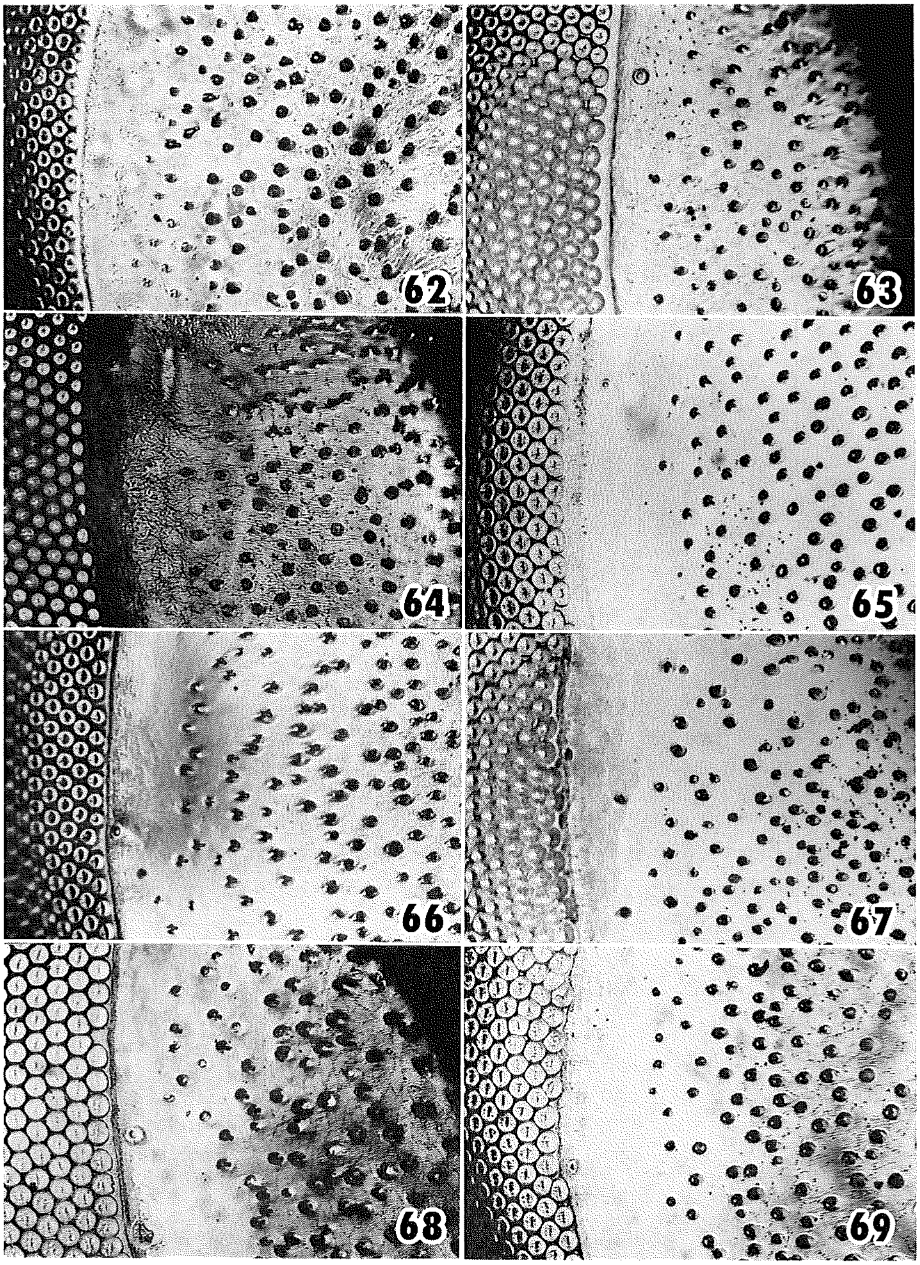
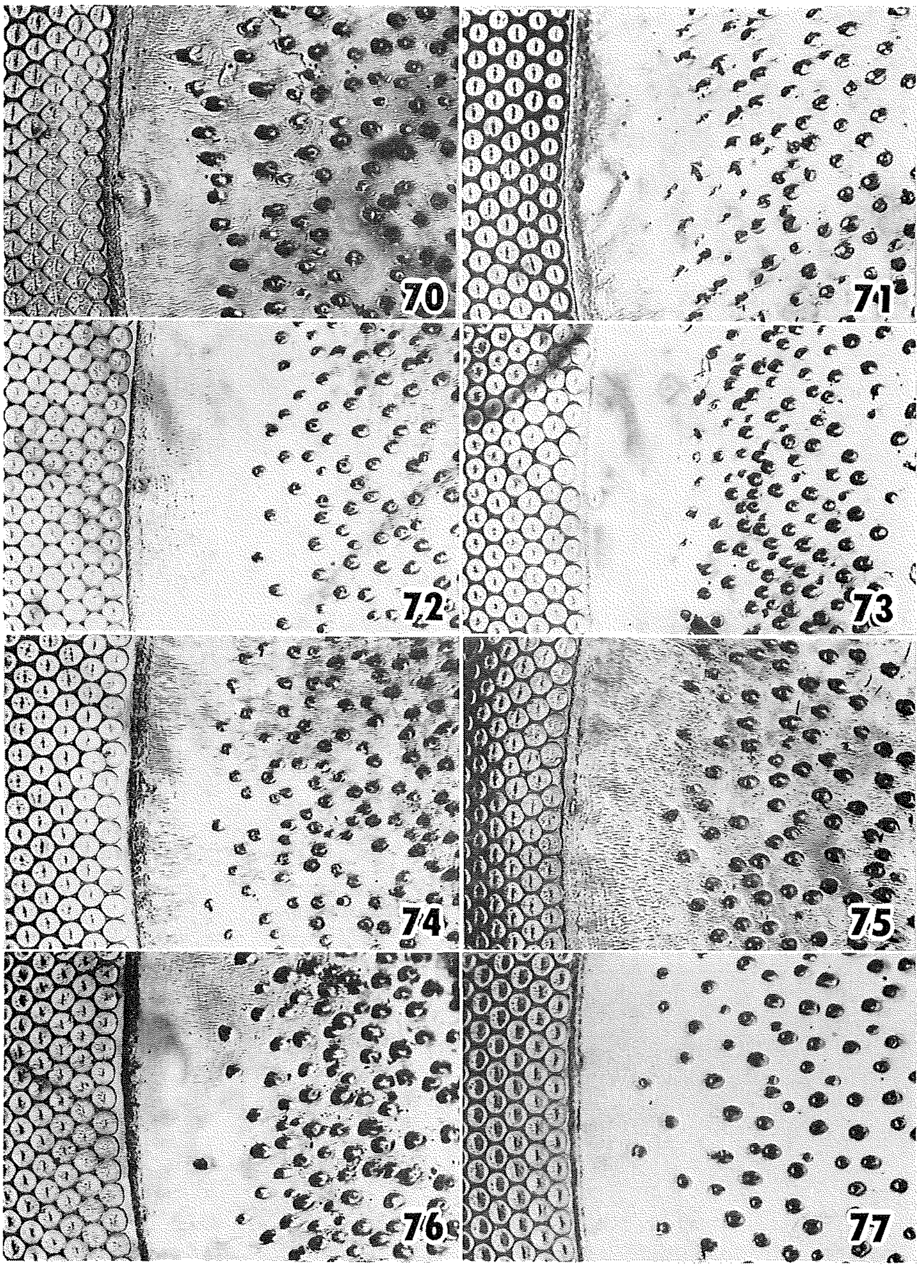
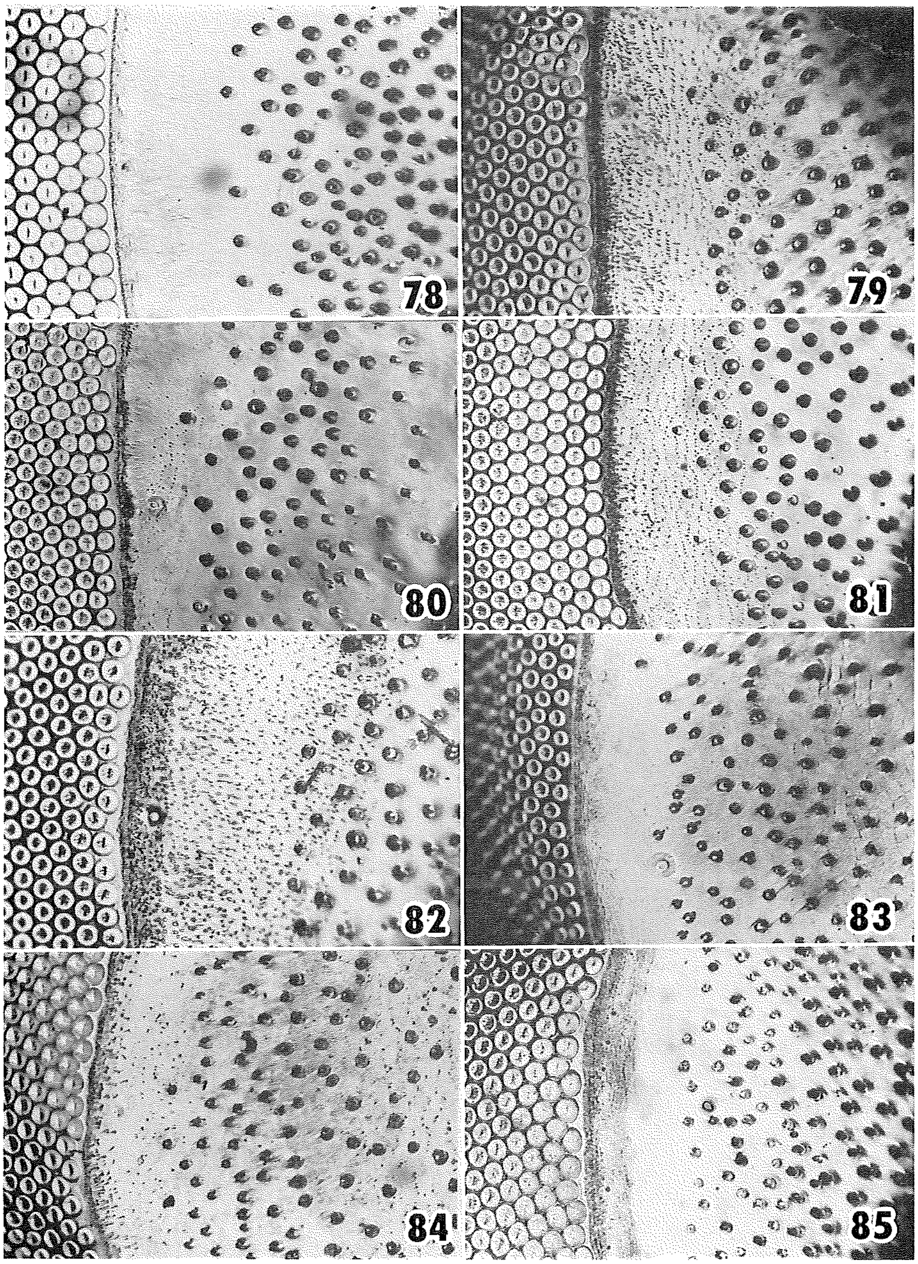


Photo 62–117. Occipital structure(× 210)

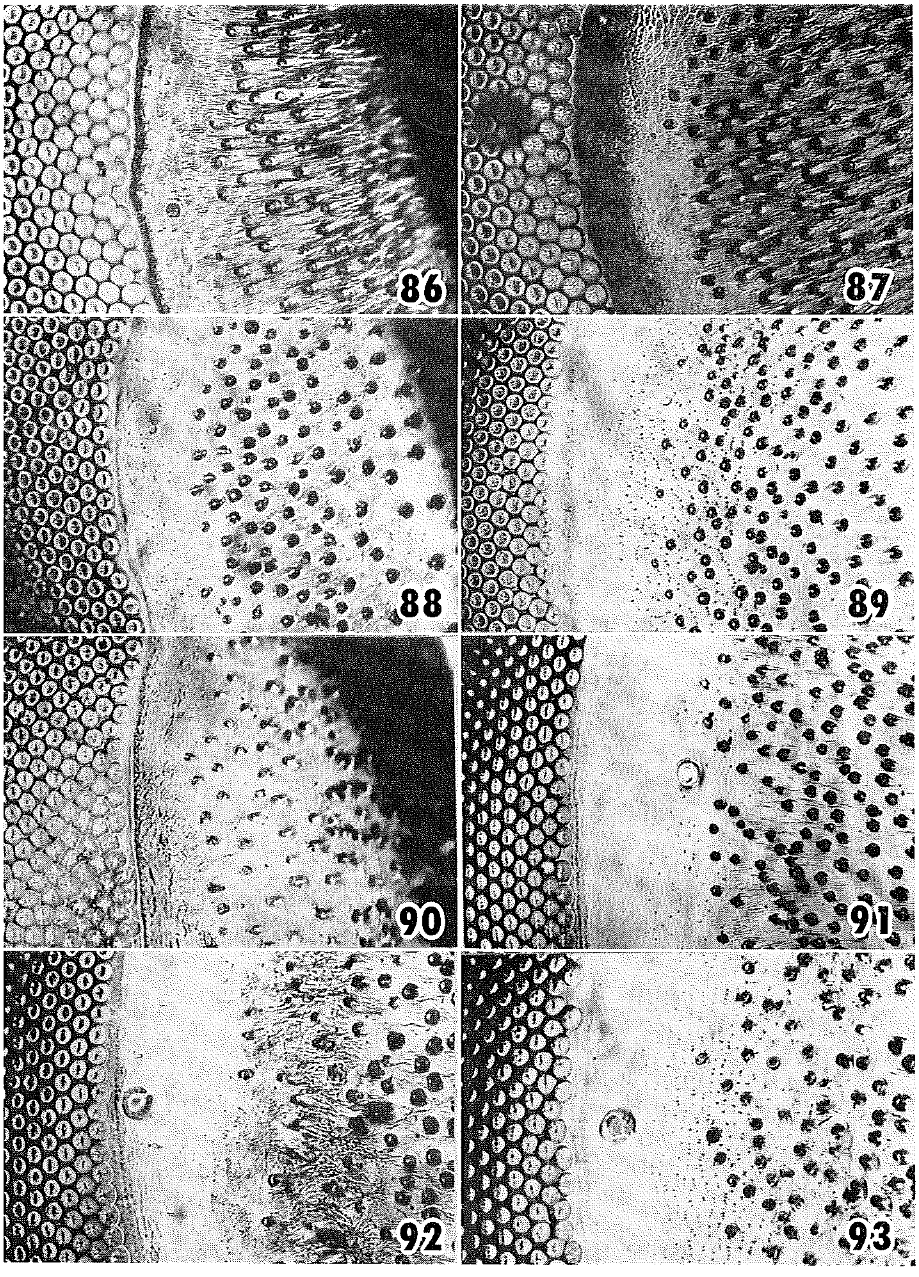
62. *Melitaea scotosia*
63. *M. diamina*
64. *Mellicta athalia*
65. *Phalanta phalantha*
66. *Clossiana iphigenia*
67. *C. thore*
68. *Brenthis daphne*
69. *B. into*



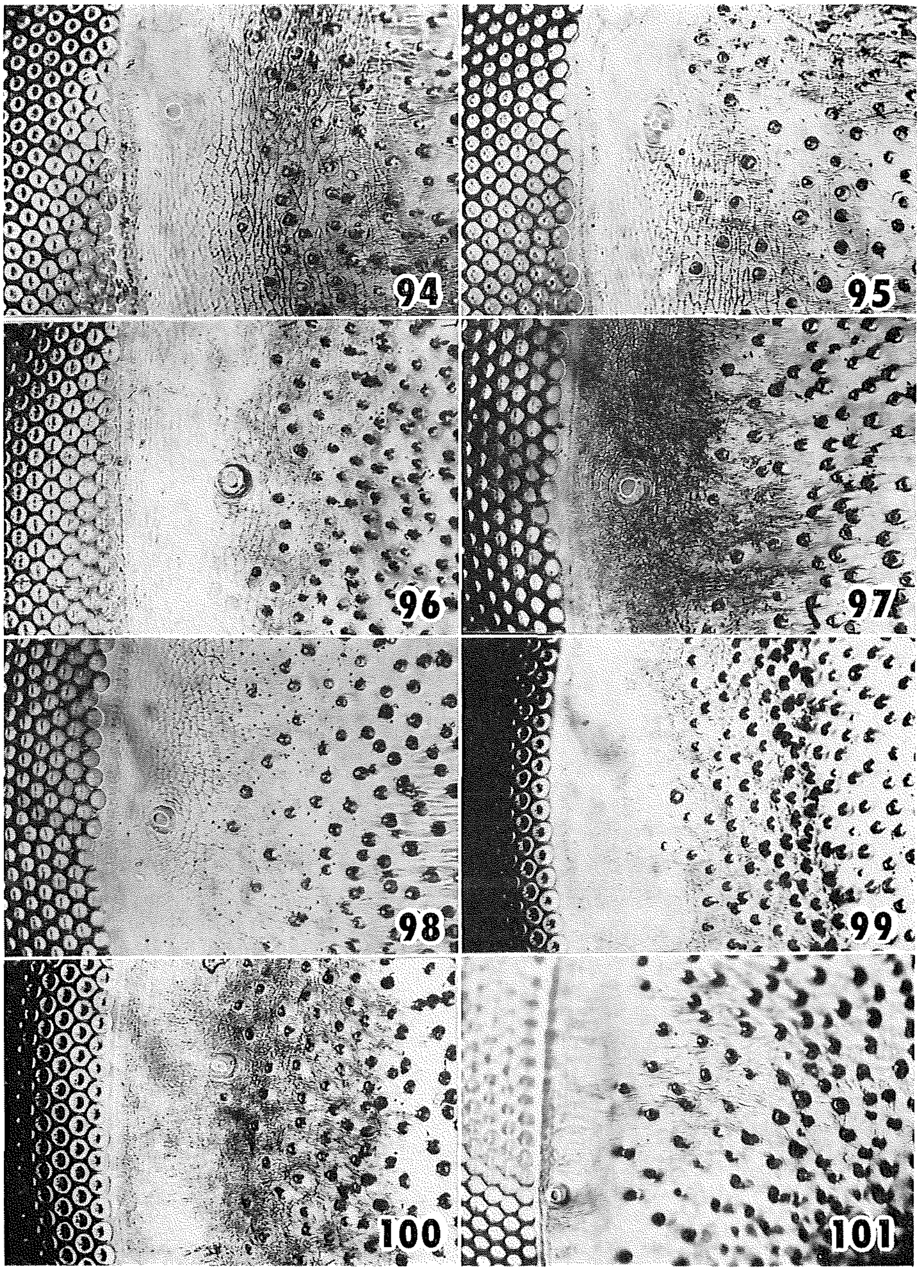
70. *Argyronome laodice* 71. *A. ruslana*
72. *Damora sagana* 73. *Nephargynnis anadyomene*
74. *Argynnis paphia* 75. *Speyeria aglaja*
76. *Fabriciana adippe* 77. *F. nerippe*



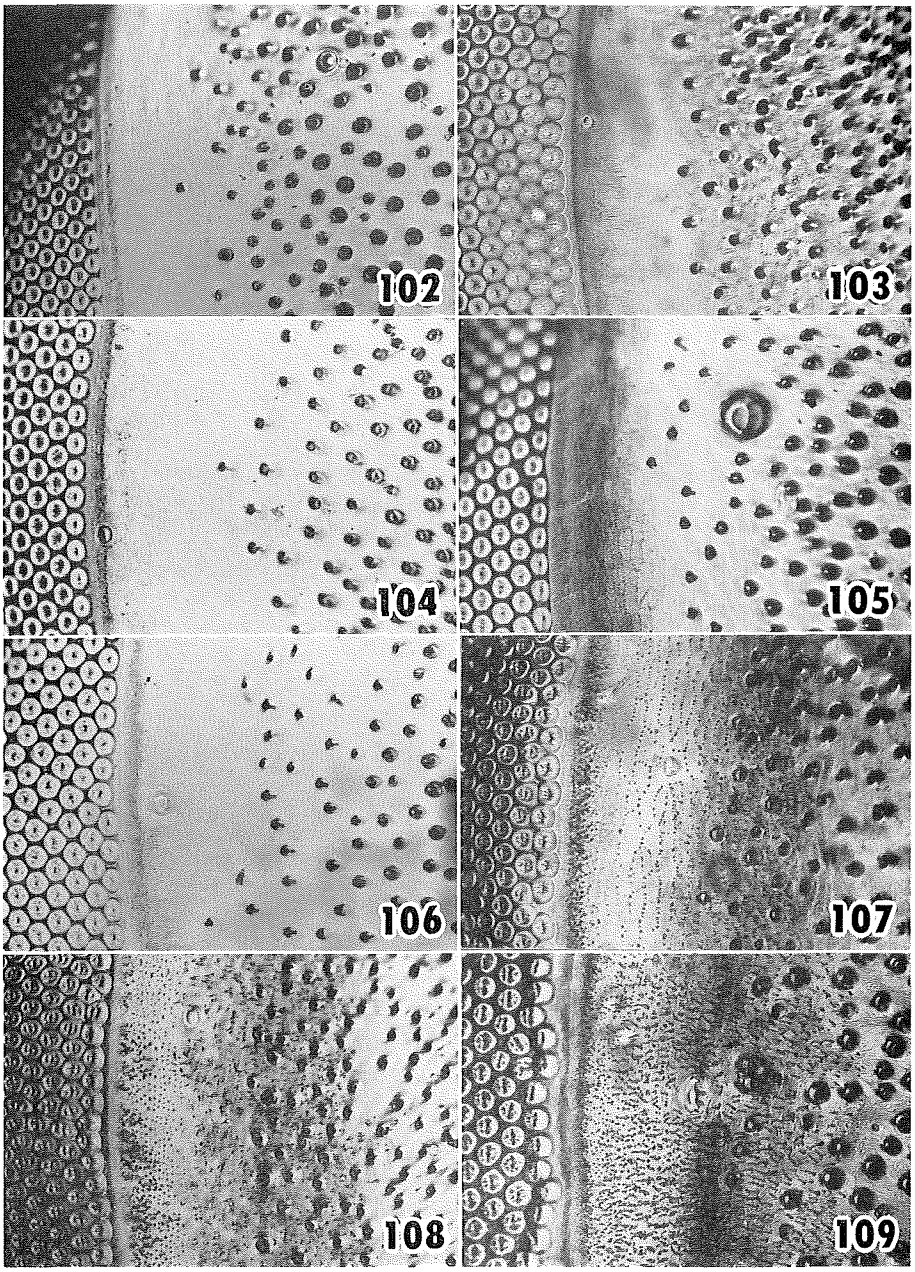
78. *Argyreus hyperbius* 79. *Athyma selenophora*
80. *Ladoga glorifica* 81. *L. camilla*
82. *Limenitis populi* 83. *Neptis sappho*
84. *N. hylas* 85. *N. philyra*



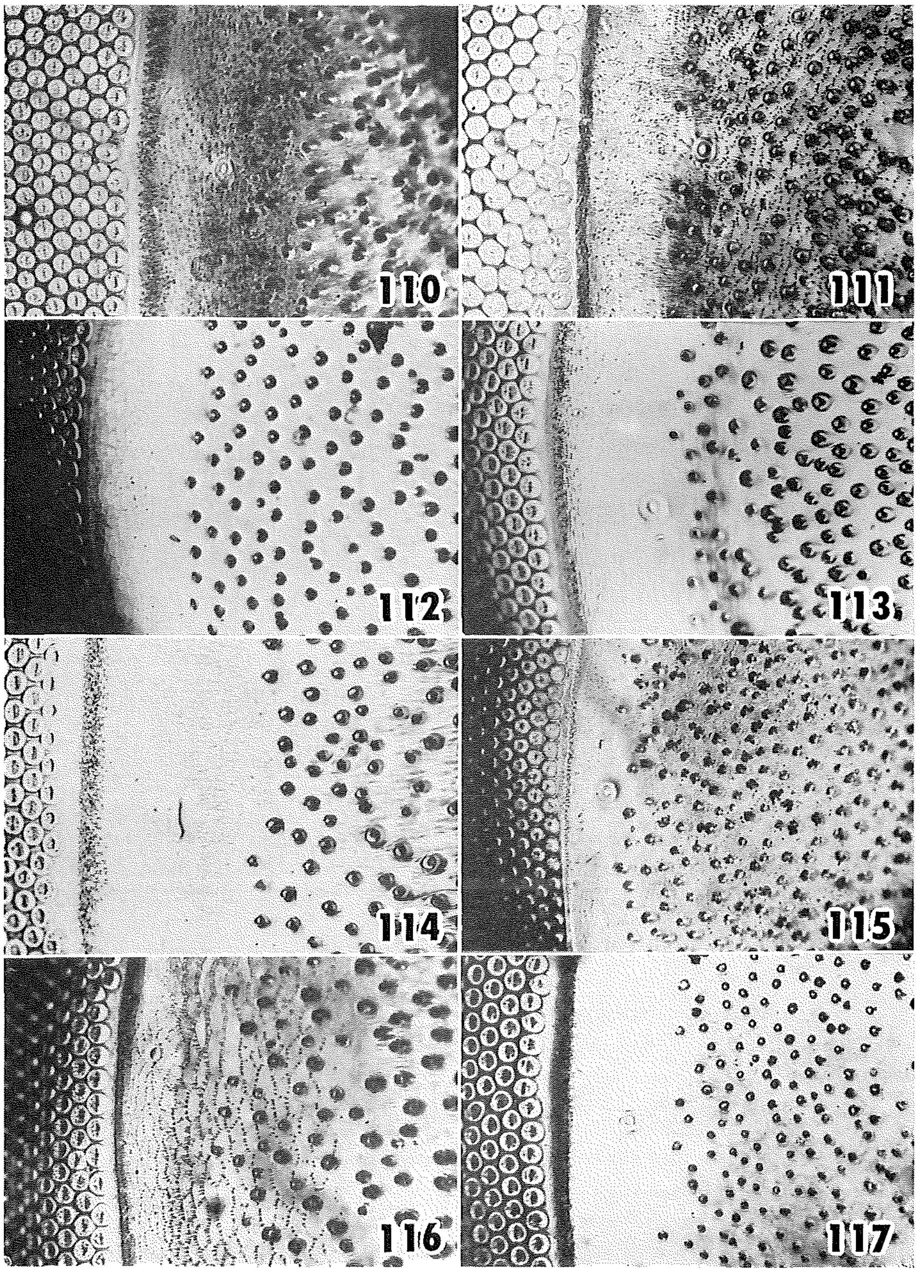
86. *Neptis pryeri*
87. *N. alwina*
88. *N. rivularis*
89. *Araschia burejana*
90. *A. levana*
91. *Polygonia c-aureum*
92. *P. c-album*
93. *Nymphalis vau-album*



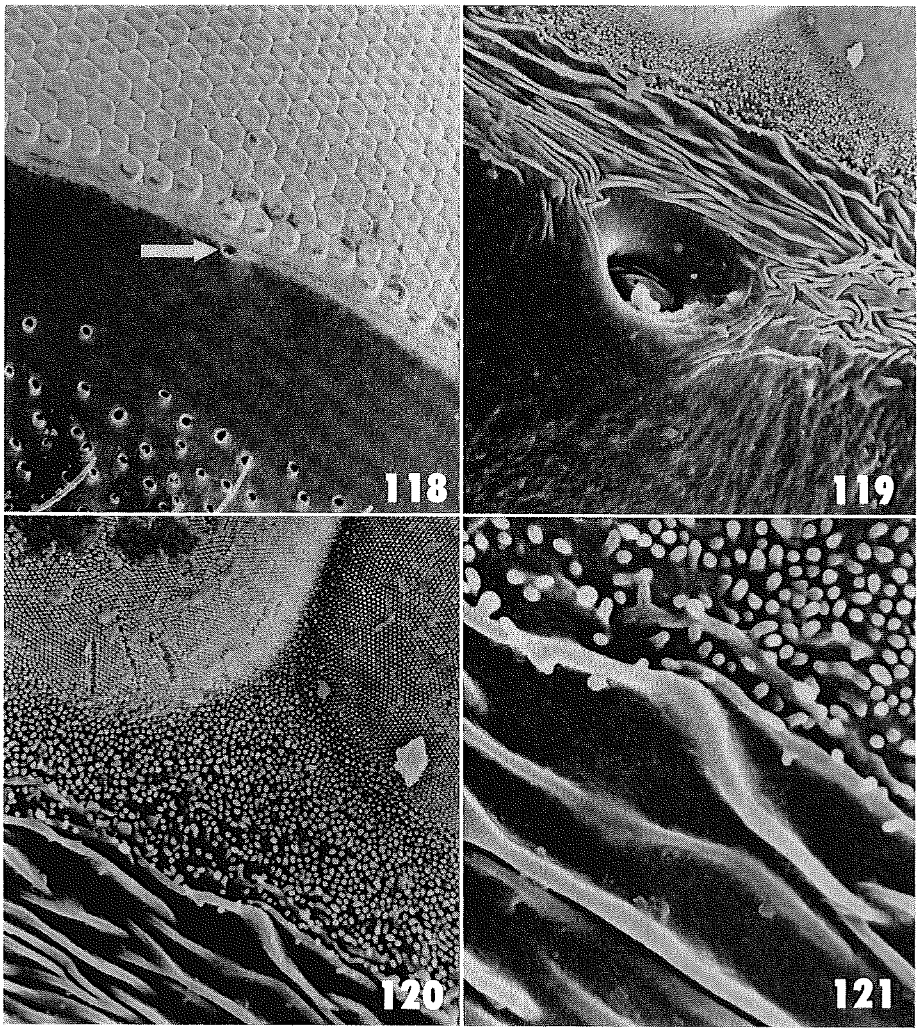
94. *Nymphalis xanthomelas*
95. *N. antiopa*
96. *Kaniska canace*
97. *Inachis io*
98. *Aglais urticae*
99. *Cynthia cardui*
100. *Vanessa indica*
101. *Precis orithya*



102. *Precis almana*
103. *Hypolimnas misippus*
104. *H. bolina*
105. *Kallima inachus*
106. *Yoma sabina*
107. *Hestina japonica*
108. *H. assimilis*
109. *Sasakia charonda*

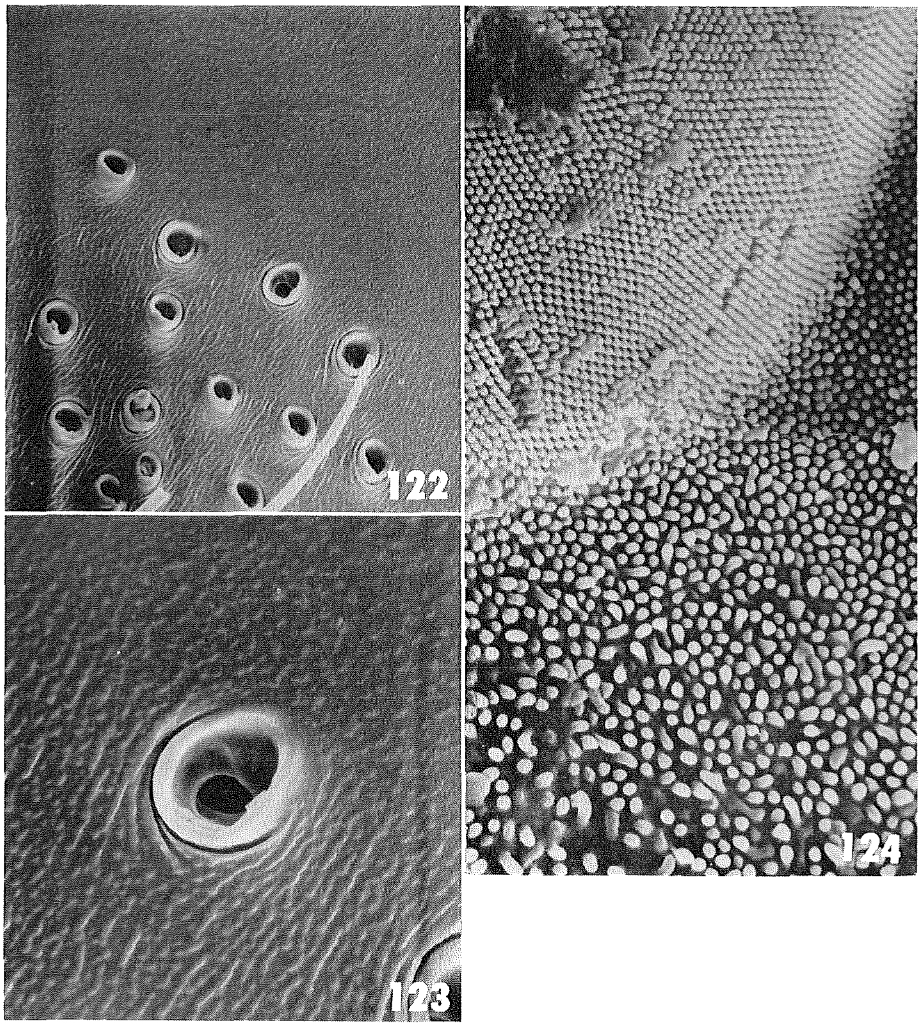


110. *Apatura ilia*
111. *Dichorragia nesimachus*
112. *Cyrestis thyodamas*
113. *Polyura eudamippus*
114. *P. narcaea*
115. *Libythea celtis*
116. *Lethe diana* (Satyridae)
117. *Parantica sita* (Danaidae)



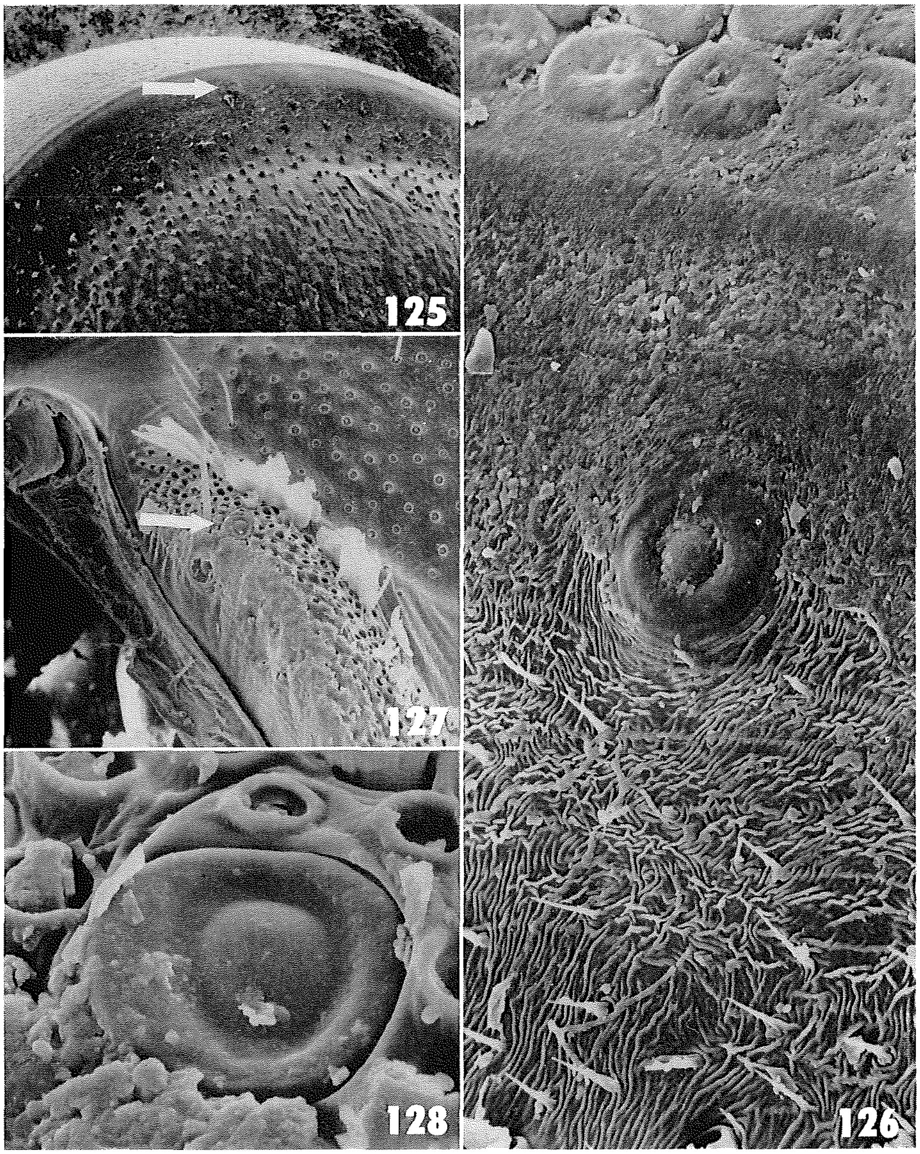
Nephargynnis anadyomene midas

118. Sensory organ (arrow), ×150.
119. Ditto, ×1500.
120. Margin of compound eye, showing small nipples, ×3000.
121. Ditto, ×7500.



Nephargynnis anadyomene midas

122. Socket cell of scale, ×75.
123. Ditto, ×1500.
124. Margin of compound eye, ×7500.



Sensory organ of *Inachis io geisha*

125. Sensory organ (arrow) found in marginal furrow, ×75.
126. Ditto, ×750.
127. Sensory organ (arrow) seen in postocciput, ×150.
128. Ditto, ×1500.

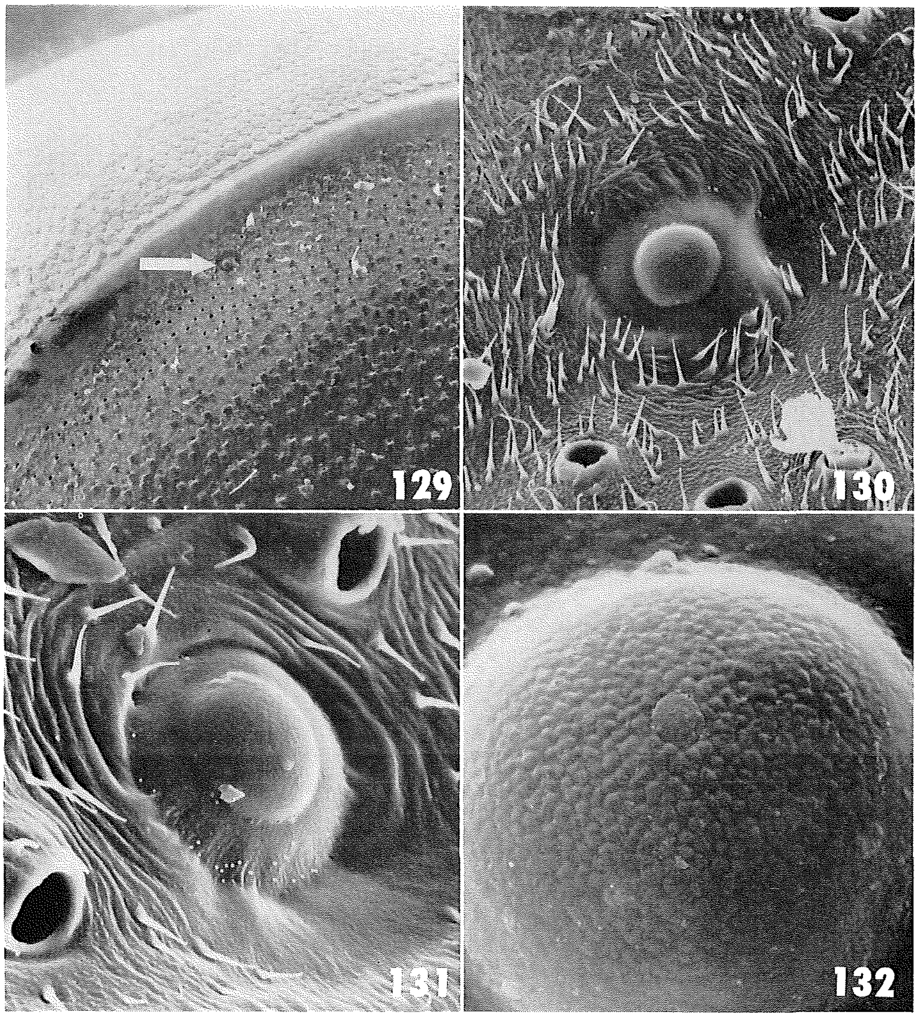
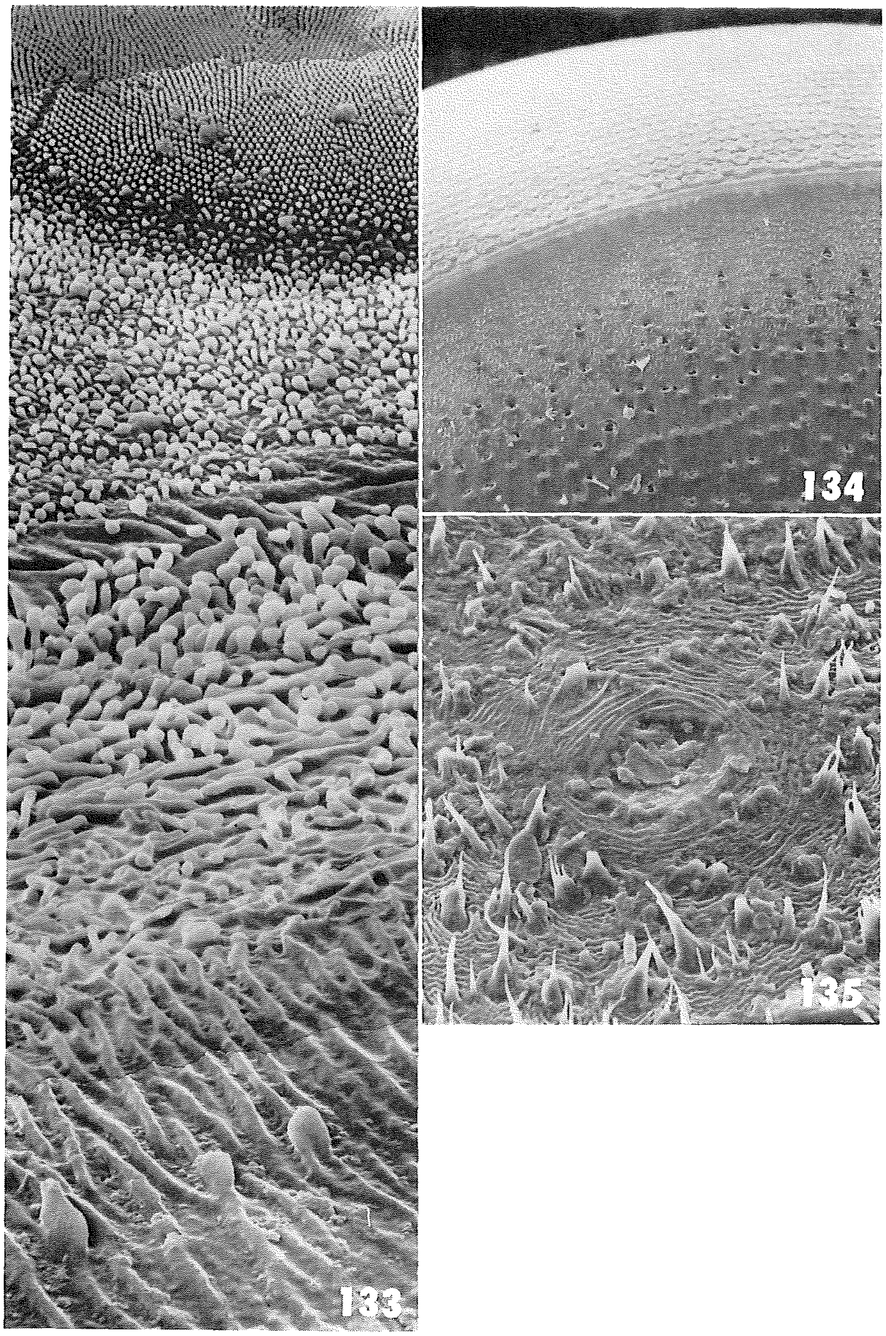


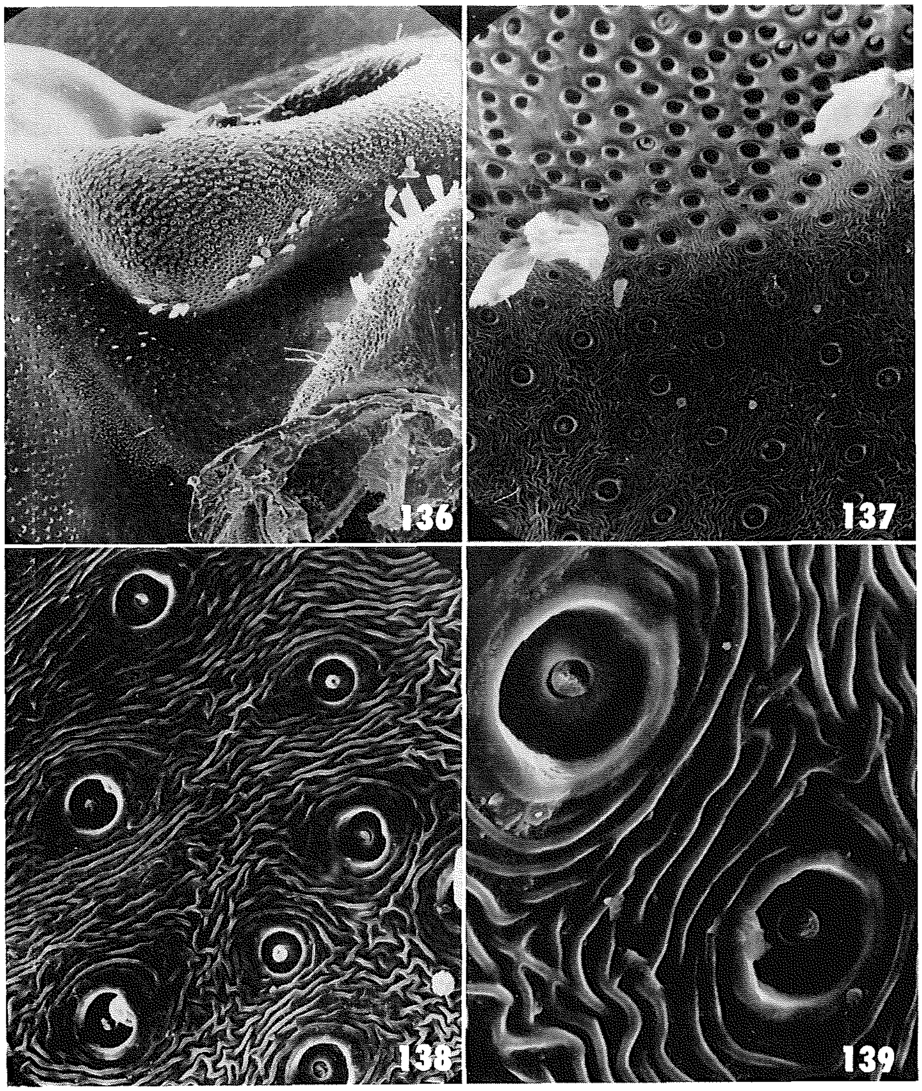
Photo 129–132. Sensory organ of *Dichorragia nesimachus nesiotes*
129 (arrow)—×75, 130—×750, 131—×1500, 132—×4500.



133. Periphery of compound eye and marginal furrow in *Dichorragia nesimachus nesiotes*, ×4500.

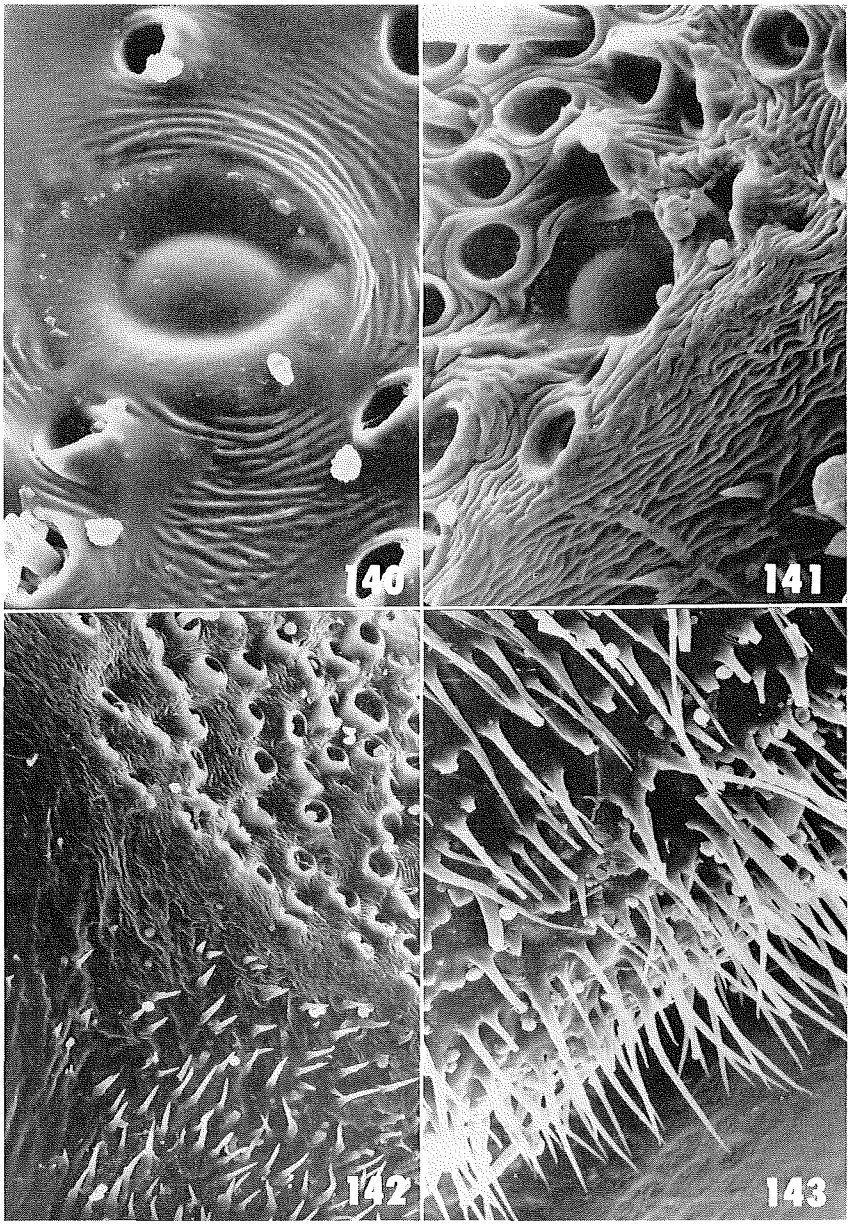
134. Marginal furrow and scale region in *Sasakia charonda*, ×75.

135. Sensory organ of *Sasakia charonda*, ×7500.



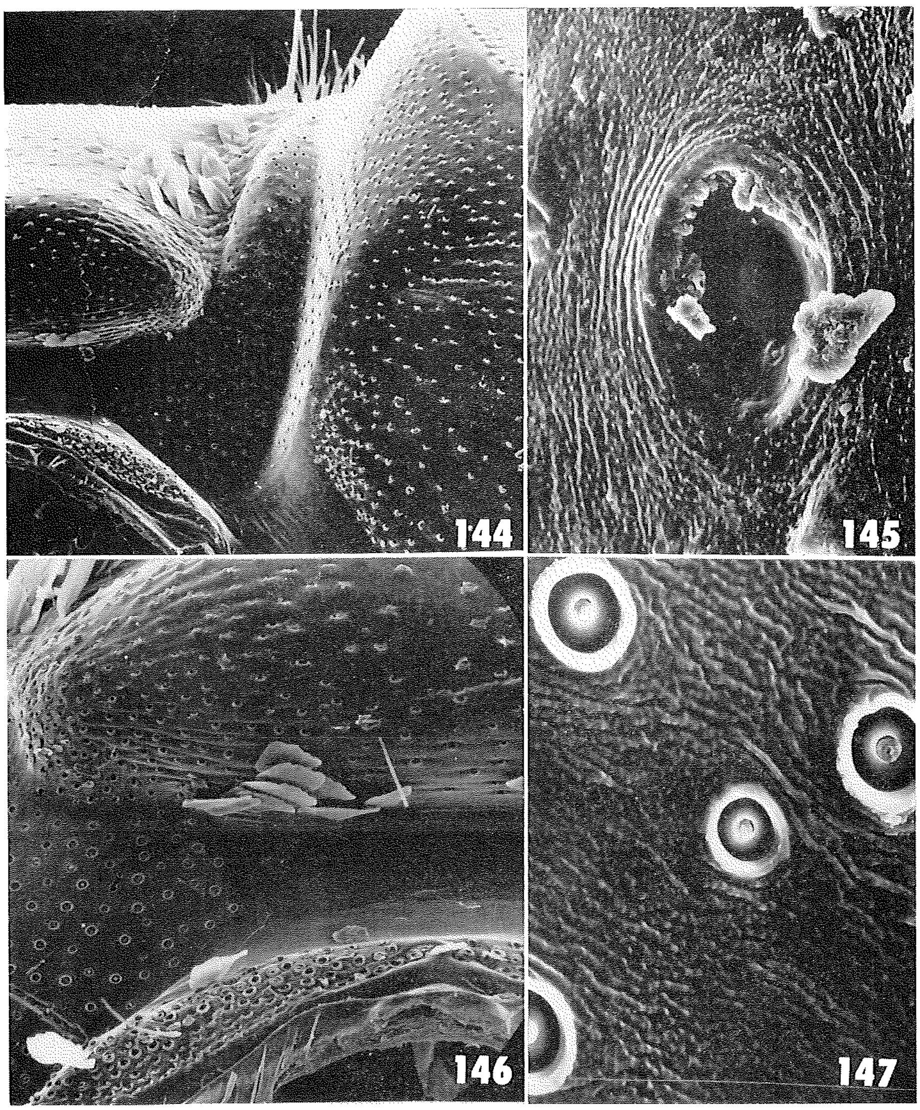
Polyura eudamippus formosana

136. Dorsal part of occiput, ×50.
137. Boundary region between occipital prominence and intermediate plate, ×300.
138. Socket cell of scale in intermediate plate, ×760.
139. Ditto, ×2300.



Polyura eudamippus formosana

140. Sensory organ in scale region, ×1,000.
141. Ditto in postocciput, ×870.
142. Peripheral region of postocciput bearing scales and small setae, ×350.
143. Small setae at ventral part of postocular plate, ×520.



Neptis sappho intermedia

144. Dorsal part of occiput, ×85.
145. Sensory organ in scale region, ×1300.
146. Connection part in which no scales are found. ×170.
147. Socket cell of scale in intermediate plate, ×1700.