

PSYCHE.

THE SEGMENTATION OF THE INSECT HEAD.

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The elucidation of the primitive segments in arthropods is a most interesting and difficult morphological problem. The rule of Savigny — emphasized by Huxley and others — that arthropods are fundamentally constructed of successive rings, each of which may bear but one pair of primary appendages, although now undoubted, has never been thoroughly substantiated when applied to the hexapod head. After years of argument, morphologists still disagree as to the number of somites composing the highly differentiated heads of insects. Compare the latest text-books in respect to the subject. Kolbe ('90) recognizes five, as follows :

1. Ursegment: Fühler, Augen, Oberlippe.
2. " Oberkiefer oder Mandibeln.
3. " Unterkiefer oder Maxillen.
- [4. " Zunge oder Innenlippe.]
5. " Unterlippe.

Sharp ('95) says, "Morphologists are not yet agreed as to their number, some thinking this is three while others place it as high as seven ; three or four being, perhaps, the figures at present most in favour, though Viallanes, who has recently discussed the subject, considers six, the number suggested by

Huxley, as the most probable. Cholodkovsky is of a similar opinion."

Packard ('98) gives six :

<i>Segment.</i>	<i>Appendages, etc.</i>
1. Ocellar (Protocerebral).	Compound and simple eyes.
2. Antennal (Deutocerebral).	Antennae.
3. Premandibular, or intercalary (Tritocerebral).	Premandibular appendages.
4. Mandibular.	Mandibles.
5. First Maxillary.	First Maxillae.
6. Second Maxillary.	Second Maxillae, or Labium. Post-gula, gula, submentum, hypopharynx, (lingua, ligula), paraglossae, spinneret.

Upon anatomical grounds, different observers have recognized from one to seven head segments. As mentioned by Packard ('98), Burmeister found only two; Carus and Audouin three; MacLeay and Newman four; Straus-Durckheim seven. Huxley ('77) said, "It is hardly open to doubt that the mandibles, the maxillae, and the labium, answer to the mandibles and the two pairs of maxillae of the crustacean mouth. In this case, one pair of antennary organs found in the latter is wanting in insects, as in other air-breathing arthropods, and the existence of the corresponding somite cannot be proved. But if it be supposed to be present, though without any appendage, and if the eyes be taken to represent

the appendages of another somite, the insect-head will contain six somites."

Huxley's conclusions were the most satisfactory that could be derived from a study of the completed organs alone and reduced the problem to these questions: Do the eyes represent a somite? Is another antennal segment represented in insects? Do the labrum and hypopharynx represent distinct segments?

Authors began to realize the impossibility of settling the problem upon purely anatomical data and attacked it from the embryological side. Packard ('71), followed by Graber ('79), found four cephalic somites: antennal, mandibular, first and second maxillary. Viallanes ('87), however, wrote the most important contribution upon the subject after studying the development of the nervous system in insects and decapod crustacea, and summarized his results as follows.

"La tête de l'Insecte est formée par six zoonites, trois sont prébuccaux et trois post-buccaux. Le premier zoonite porte les yeux composés et les ocelles. Le deuxième les antennes. Le troisième, qui est dépourvu d'appendices, porte le labre, pièce qui, pas plus chez les Insectes que chez les crustacés, ne peut être considérée comme le résultat de la soudure de deux appendices. Le quatrième zoonite porte les mandibules, le cinquième les mâchoires, le sixième la lèvre inférieure." These conclusions have been confirmed by Wheeler ('93), Heymons ('95, '97) and others.

Rudimentary intercalary, or premandibular, appendages have been found

in Anurida (Wheeler '93, Claypole '98) and Campodea (Uzel '97), and the last two authors have homologized them with the crustacean second antennae. I may add that rudimentary chitinized intercalary appendages persist in adults of *Tomocerus*, *Orchesella* and other *Collembola*.

Six cephalic somites are the most that have been admitted upon embryological grounds—but I am convinced that six are not adequate. To prove this statement, I must give a preliminary summary of some recent studies upon the anatomy and development of apterygote mouth-parts.

The hypopharynx in *Collembola* and *Thysanura* consists of three parts: a median ventral lingua and two dorso-lateral *superlinguae*, hitherto termed "paraglossae," but quite distinct from the labial structures with the same name. In the embryo of *Anurida maritima*, the *superlinguae* originate as a pair of simple papillae between the mandibles and first maxillae and slightly nearer the median plane. The *superlingual* anlagen are ectodermal evaginations containing intrusive mesoderm and are histologically undistinguishable from the anlagen of the remaining appendages. The lingua appears as a subsequent and quite independent median evagination of the first maxillary segment and becomes supported by a pair of lateral chitinous stalks which originate in superficial grooves of the germ band.

Soon after involution has occurred, just seven pairs of cephalic ganglia are

seen and — important facts — the third pair belongs to the intercalary segment and the fifth to the superlingual somite. The lingua has no ganglia. Later, the first three pairs unite to form the supra- and the remaining four, the suboesophageal ganglion.

More conclusive proof that the intercalary and superlingual appendages represent primitive segments, of which there are seven, could hardly be expected.

In Campodea (Uzel '98) and Ephemera (Heymons '96) the hypopharynx originates as three independentanlagen and several authors have held it to represent a somite upon anatomical grounds. The hypopharynx of highly specialized insects, however, I find to be homologous with simply the *lingua* of Collembola and Thysanura, although the superlinguae are represented in the more generalized Pterygota but have usually been overlooked or disregarded.

Among Apterygota the lingua and superlinguae do not unite, although their three cavities become basally confluent with the general body cavity. In Orthoptera and Ephemeridae, however, the superlinguae are firmly united with the lingua. Although often conspicuous in the latter group (Vayssière '82), the superlinguae are less so in Orthoptera but I have found them as distinct lobes in all families of the order. The chitinous lingual stalks, important in Collembola and Campodea, become reduced and functionless in Machilis and Lepisma but occur as rudiments even in Orthoptera,

including Hemimerus (Hansen '94). Miall and Denny ('86) have figured them for *Periplaneta* and I have found them clearly in *Melanoplus femoratus*.

There are striking and detailed agreements between the anterior somites of insects and decapod crustacea. Viallanes ('87) and Hansen ('93) have emphasized the fact from their respective standpoints of embryology and comparative anatomy. My own results, confirming and supplementing their views, may partially be expressed in tabular form. Between such divergent groups, of course, homologies indicate nothing more than a parallelism in development.

EQUIVALENT PAIRED ORGANS.

Somite	Hexapoda	Crustacea
1	Compound eyes	Compound eyes
2	Antennae	Antennules
3	Intercalary appendages	Antennae
4	Mandibles	Mandibles
5	Superlinguae	First Maxillae
6	First Maxillae	Second Maxillae
7	Labium	First Maxillipedes

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DESCRIPTIONS OF THREE NEW SPECIES OF ALEURODIDAE FROM BRAZIL.

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Aleurodes horridus n. sp.—*Pupa-case*.—Length, 1 mm.; elliptical in outline, flat; light yellow in color. The dorsal surface is covered with white secretion, arranged in a median longitudinal row, and a submarginal row on each side. Around the margin there is also a very short fringe of white wax. These details are however obscured by a mass of long yellowish, hair-like secretion, that envelopes each individual. Denuded of wax, the margin is found to be doubly crenulated, with the posterior end of the body rounded and the anterior end forming an obtuse angle. The dorsum is slightly wrinkled, and has a short median longitudinal ridge, extending from the anterior end to nearly the middle of the body.

Vasiform orifice subelliptical, broader than long. Operculum hemispherical, nearly fitting the orifice, the free end notched. A long seta is situated on each side of the orifice; two on the caudal end of the body; and two on the ventral surface of the body just cephalad of the middle. No traces of antennae or legs were found.

Adult ♀.—1.08 mm. long, yellow, eyes black; wings transparent, yellowish, covered with a white powder. Antennae of seven joints. Joints 3-7 fine, cylindrical, slender; joint 2 large, club-shaped. Legs long and slender, nearly reaching to the apex of the closed wings.

Hab.—On the underside of leaves of guava, *Psidium* sp., from S. Paulo, Brazil. Accompanied by a species of ant (*Creमतogaster*).

Aleurodes fumipennis n. sp.—*Pupa-case*.—Elliptical, convex, black, 1.8 mm. long. There is a prominent median longitudinal, dorsal ridge, and about six transverse furrows. The lateral margin is thick with a conspicuous groove on the dorsal surface, and a short fringe of white wax on the ventral surface. Near the posterior end, around the vasiform orifice, there is a large hemispherical area, nearly transparent, but dusted with white secretion. The lateral margin is slightly notched in places, but not crenulated. Vasiform orifice hemispherical; operculum small, rectangular, fitting the



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