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A REVISED, ANNOTATED LIST OF TERMS USEFUL FOR MORPHOLOGICAL
STUDIES OF MONOGENETIC TREMATODES

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The following terms are considered useful to morphological studies of monogenetic trematodes. They are presented in an effort to clarify and subsidize this important phase of morphological research. Most have been either introduced or used by Price (1934 to 1943b), Sprston (1945 and 1946), Muelie (1938), Dawes (1947) or Hargis (1954).

I. Haptors - anterior and/or posterior organs of attachment.

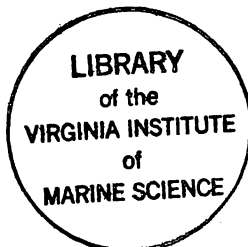
A. Prohaptor - anterior holdfast.

1. Head organ complex - an adhesive unit, probably secreting mucus and consisting of the following elements:

- a. Head organs - glandular and conducting structures, usually multiple, discrete and situated marginally.
- b. Cephalic glands - usually a cluster of glandular cells situated near the pharynx and connected by ducts to the head organs or buccal funnel. Sticky glands of Yamiguti (1953).

2. Suckers

- a. Anterior suckers - discrete, shallow, concavoconvex, muscular suckers, opening ventrally, usually present in pairs and located anterolaterally (Benedenia).
- b. Oral suckers - discrete conspicuous, muscular lip surrounding the mouth (Hexabothriidae).



c. Pseudosucker - weakly muscular lip surrounding the mouth, not clearly demarcated like the oral sucker, probably acts as a sucker and may or may not possess an extra membranous lip or flap (Monocotyle or Heterocotyle).

d. Buccal suckers - cylindrical or hemispherical, muscular suckers placed laterally in the walls of the buccal funnel, may have many tooth-like sclerites on their rims and each may be divided by a septum, i.e. biloculate. Occur in all known Diclidophoridae.

B. Opisthaptor or Posthaptor - modified posterior end of body which functions as a holdfast, actually a morphological entity and not just a term denoting function. It may be only an expanded posterior area with anchors and haptor hooks (Tetraonchinae), or a concavoconvex disk opening ventrally (Capsalidae), or a cotylophore bearing multiple suckers or clamps (Polyopisthocotylea). In many cases the opisthaptor of the embryo is retained and perhaps added to in ontogeny. This type is evidenced by the presence of marginally placed hooks (Tetraonchinae, Monocotylidae, Polystomatidae). In other cases the larval opisthaptor may be partially or completely lost and replaced by a new, anteriorly located one (many Diclidophoroidea). Some species (Protomicrocotyle) have both types in one individual in the adult stage. The hard parts of the opisthaptor are of particular taxonomic importance because they reach their maximum stage of development much earlier than most of the soft body parts and are much less susceptible to distortion during collection and treatment. Because of their stable nature, measurements of these structures are more reliable than those on soft parts. The same can be said for other cuticularized structures, such as the cirri, accessory pieces and vaginae.

1. Anchors - large, medially placed hook-like structures functioning as movable grapnels or tongs. Many monogenetic groups have anchors either in the larval or both larval and adult stages. It is probable that the anchors and their parts, as well as the hooks, are homologous throughout the entire order and are of corresponding taxonomic importance. All

large hook-like structures present at the posterior end of the Dactylophoroidea are arbitrarily called anchors, although some may be embryonic hooks. It is almost certain, however, that the largest ones actually are anchors. The various anchor parts are:

- a. Roots - proximal, imbedded end of the anchor; usually forked and in two parts with the superficial root pointing in the same direction as the anchor tip (outward), and the deep root in the opposite direction to the tip curve (inward).
 - b. Base - root junction.
 - c. Shaft - more or less straight portion of the anchor between the base and the tip. The term shaft is often used for that structure in Capsaloidea and Polyopisthocotylea anchors which is probably homologous to the deep roots of Dactylogyridae anchors.
2. Hooks or Eaptoral Hooks - small hooks, usually marginally located but sometimes situated medially near the anchor bases. Usually sickle-shaped but may be much modified in shape. Present in the larval stages of most Monogenea, excluding perhaps the Microcylindidae whose monogenetic affinities have been questioned; retained by the adults of many (Gyrodactyloidea, Capsaloidea, Polystomatoidae).
 3. Bars - transversely situated, elongate sclerites which may or may not articulate with the anchors, often serving as pivots or spreaders for them. Present mostly in the superfamily Gyrodactyloidea.
 4. Accessory groups of spines and parts of various types of plaques (see below) may also occur on the peduncle (Diplectaninae).
 5. Capsaloidea-type posthaptor - disk-like concavoconvex sucker, septate or aseptate, usually armed with anchors and marginal hooks, often with a marginal membrane. The terminology of the various components of this type sucker is:

- a. Septa - cuticular, apparently flexible, ridges, perhaps muscular, which divide the haptor into loculi or depressions (Monocotylidae).
- 1) Central septum - surrounds central depression.
 - 2) Radial septa - radiate from central septum and delimit the radial depressions,
 - 3) Marginal septum - surrounds margin of the entire disk.
 - 4) Marginal radial septa - short septa which project radially from the marginal septum.
- b. Ridge sclerites - small sclerites surmounting the septa, with free ends projecting ventrally and probably adding adhesive advantage, named according to the septum upon which they are situated, i.e. central ridge sclerites on the central septum, radial ridge sclerites on radial septa, etc.
- c. Depressions - concave areas, usually opening ventrally, called loculi by others, i.e. central depression, radial depressions, marginal depressions, multiple, asymmetrically arranged depressions may be present rendering naming difficult, (as in Cathariotrema).
6. Cotylophore or polyopisthocotyleid-type - usually bearing multiple suckers (Polystomatoidea) or clamps (Diclidophoridae) or clamp-like suckers (Choricotylinae). MacCallum and MacCallum (1913), Price (1936), Sproston (1946) and others have stressed the taxonomic importance of clamp structure in the latter group, the value of these structures is enhanced by the fact that they are external; they have durable, cuticularized skeletons; they attain adult size and shape earlier than do other parts and; in addition, their structural details are correlated with the structure of internal organs and their parts are probably homologous throughout the entire group (Hargis, 1956, 1957, and 1958). The writer concurs with the above workers in their evaluation of the systematic value of the clamps.

One reason behind the relatively poor taxonomic condition existing in the Diclidophoroidea has been the lack of an adequate, terminology for the clamp parts. Therefore, a fairly detailed terminology is presented below. Most of these clamp terms were proposed by Sproston (1945) and are accepted by the present author.

- a. Polystomatidae-type - disk-like, outline polygonal with two or six cup-like, heavily cuticularized suckers. Anchors may be present or absent. Larval hooks may be present in the bottoms of the sucker cups and, in addition, are often scattered on the rest of the disk. Odd-bottle or flask-shaped sclerites called ogives often located with hooks in the suckers.
- b. Hexabothriidae-type - may be angular or disk-like, bearing six armored suckers, also bearing an armed haptoral appendix.
 - 1) Suckers - cuplike, cuticularized, rims often studded with numerous small conical spines, may have conspicuous, shallow, lateral expansions called sucker shelves.
 - 2) Hooklike sclerites - oddly-shaped hooks associated with the main suckers. Derivations and homologies unknown at this time, possibly homologous to the anchors of other monogeneids, or, more likely, to the center pieces of Chimaericolidae, typically hexabothriid.
 - 3) Haptoral appendix - cylindrical muscular prolongation, usually bearing two terminal appendix suckers and usually possessing a pair of appendix anchors that are probably homologous to the anchors of other Monogenea.
- c. Diclidophoroidea-type - may bear from seven to 100 more clamps or sucker-like clamps, usually in two ventro-lateral rows.
 - 1) Clamps - structures which are so fashioned that they are able to pinch host tissue between opposable moities, called valves. Sometimes

proposed by Hargis, (1952) and is considered preferable to the ambiguous "spring" employed by Sproston (1945 and (1946) for both the middle loop and the dorsal loop sclerites as well as the center piece itself. Obviously the use of the same term for several different elements in the same structure renders the study of homologies difficult. In addition, the use of such ambiguous terms in biological keys is very confusing.

- e) Accessory middle loop sclerites - extra sclerites which are curved, often sigmoid in shape and arranged in an inverted V. in the distal part of the middle loop valve (Gastrocotylidae).
 - f) Accessory wall sclerites - numerous short sclerites located in the valve wall of the clamps (Gastrocotylidae).
2. Sucker-like clamps - used to denote clamps whose loops are opened and flattened out. Apparently this type of clamp is no longer capable of clamping action but functions chiefly as a reinforced sucker (Choricotylinae). All sclerites are probably homologous of other polyopisthocotyleids (Hargis, 1956).
- C. Peduncle structures - either cuticularized; and external or glandular and internal. Located in or on peduncle. Found mostly in Diplectaninae or Tetraonchidae.
- 1. Plaques - complex holdfasts which are superficially located in the posterior body region. Probably derived from the cuticle that region. Commonly on Diplectaninae. Includes the following structures or types:
 - a. Lateral plaques - lateral expansions on the peduncle which may consist of many hook-like spines in a longitudinal row, or a plain, raised cuticular area as in Rhabdocyathus.
 - b. Dorsal plaques or ventral plaques - sub-rectangular groups of hook-like spines. Mostly on the peduncle, but may overlap the anterior opisthaptor margin (Pedunculospina, etc.).

- c. Squamodisk - circular or oval structures consisting usually of concentrically arranged groups of spines, "rodlets", modified scale-like spines or cuticularized lamellae. Usually on the opisthaptor but may overlap or be entirely on the peduncle.
2. Peduncle glands - generally clavate, differentially-staining masses of apparently glandular tissues. Usually there are two, placed laterally in the peduncle; probably opening to outside or near opisthaptor surface. Called cement glands by Yamaguti (1953) and others. Frequently a slightly staining, translucent peduncle bladder or bladder-like structure is found between the two peduncle glands. Its function is unknown, perhaps a reservoir for material of the peduncle glands. Called cement reservoir by Yamaguti (1953).

II. Genitalia

- A. Internal genitalia - Sproston (1946) reported that there appears to be alternation of sex phases in some Monogenea. Judging from morphological evidence this alternation does not appear to be the simple protandry found in some Digenea but a true alternation of sex phases. To what extent possible precocious self or cross-copulation and sperm storage affects the reproductive significance of this alternation of sex phases is unknown.
 1. Ootype-uterus complex - term used when the ootype and uterus are indistinguishable morphologically as in some Monocotylidae. If these structures are distinguishable the names are used separately with the ootype as that part immediately anterior to or surrounded by Mellis gland where the eggs are formed.
 2. Glands of Goto - small, glandular elements, usually bean-shaped, which are posterior to the testes in some Capsalids. Possibly not genital in function, but included here because of their proximity to the testes.

B. Terminal genitalia - cirrus complex, vaginal complex, etc.

1. Cirrus complex - male terminal genitalia, consisting of the cirrus or introit organ and accessory structures, most often cuticularized. Various parts as follows:

a. Cirrus - used for any introit organ, whether protrusible (penis as defined by Dawes, 1947), or both protrusible and eversible (cirrus as defined by Dawes, 1947). The separate terms of Dawes are not employed because cirrus has been used consistently by workers in the Monogenea in reference to organs which have one or both types of action.

1). Cirrus ornamentation - any sculpturing, e.g. cirral threads, cirral vanes, or fins, which is attached directly to the cirrus itself, usually cuticularized like the cirrus (some Gyrodactyloidea and some Capsaloidea).

b. Accessory piece or pieces - cuticularized structures, either somewhat rod-shaped or ribbon-like, often very bizarre, separate from the cirrus itself, may be of assistance in copulation. Most highly-developed in the Tetraonchinae. Herein differentiated from the cirrus ornamentations which are attached directly to the cirrus. This point is stressed because accessory pieces have been used by some taxonomists to distinguish various groups and various workers have failed to distinguish between them and cirrus ornamentations. At times, it is very difficult to tell whether a cuticularized piece is actually attached to the cirrus or not.

- c. Cirrus bulbs - usually ovoid and cuticularized, at base of cirrus. In some groups (Benedeniinae and others) it may contain a prostate reservoir and seminal vesicle. In others it appears to be a hollow chamber which may act as both a prostate reservoir and seminal vesicle.
 - d. Cirrus sheath - cuticularized sheath which surrounds the cirrus in some (*Stenopoda*).
2. Genital corona - often a hemispherical, ring-shaped muscular plate, may consist of a single muscular structure or two pieces side by side, armed medially by hook-like spines (Discoctylidae and Choricotylinae). In many cases the precise functioning is not understood. The corona often appears to be nothing more than the muscular, armed walls of the genital atrium. The function of the corona, presumably, is to secure the intromittent organ of the mate during copulation. Price (1943b) called it a "cirrus" in Choricotylinae. The term genital corona is used for all muscular and/or armored structures of the atrial region which are morphologically similar until it can be demonstrated that they are actually intromittent organs or cirri.
3. Vaginal complex - considered of two parts as follows:
- a. Vaginal pore - outside opening of the vaginal.
 - b. Vaginal tube - vaginal duct, often cuticularized, extending from the vaginal pore to either the seminal receptacle or the oviduct.

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