Svensk Botanisk Tidskrift. 1910. Bd 4, H. 3

CYNOMORIUM AND *HIPPURIS*.

BY

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Some years ago I published an investigation of the history of the development of *Cynomorium*. The systematic position of this strange parasitic plant is still wrapped in darkness, because to the Balanophoraceae, with which it was in former times combined, it probably has no closer relations. On the other hand, different authors referred to a certain similarity in the construction of flowers between *Cynomorium* and *Hippuris* and for a relationship between these two expressed genera themselves. Somewhat more recently, to examine this hypothesis I made an evolutionary study of *Hippuris vulgaris*. With this investigation I am already in large part finished, only before I can publish it, I must have more materials for the study of the fertilization, which is to be pursued here quite with difficulty and deviates from the usual type. These lines [of text] are now a type of provisional report on this *Hippuris* work. I will mention meanwhile mainly only such results of my investigation, which can be about the question of importance about the relationship between *Cynomorium* and *Hippuris*.

J. D HOOKER might have been first who accepted a relationship between the Balanophoraceae and the Halorrhagidaceae. In his Monograph of the Balanophoraceae (1859) he emphasizes the similarity between *Lophophytum* and *Gunnera*, then in addition, between *Cynomorium* and *Hippuris*. As common for latter genera it indicates the following characteristics: a single, epigynous stamen on an ovary, which consists of a single carpel, with a only one hanging ovule and a style. With reference to HOOKER'S representation also HOFFMEISTER takes on (1859, p. 603) the relationship between *Cynomorium* and *Hippuris*, EICHLER (1878, p. 545) finds noteworthy this opinion, to CARUEL (1876, p. 41) who believes to be able to confirm it by the history of the development, and he finds finally also with ENGLER (1907, p. 175) an expression, by specifying the Suborder Hippuridinae and Cynomoriinae beside each other at the end of the Myrtiflorae.

Among modern authors PIROTTA and LONGO (1900, p. 114) are the only ones, so far as I know, who put *Cynomorium* in a far lower place in the system. They proved that this genus is characterised by "aporogame Acrogamie", i.e. that the micropylar region is occupied by a closed tissue that the pollen tube grows through. They regard *Cynomorium* therefore as a genus, which connects in an excellent series to the lower porogamen, by Basigamie or Mesogamie (Amentiferae, Urticineae) to the higher numbers of the Choripetalae.

Just like *Cynomorium* was removed from the family Balanophoraceae, then *Hippuris* was also removed [torn off] in a latter time from the federation of the Halorrhagidaceae. SCHINDLER (1904-05), implemented this operation, emphasized that except that they have a similarity in habit, no common characteristics can be exhibited between *Hippuris* and the Halorrhagidaceae. However, perhaps it goes too far since it completely rejects the attempts (e.g. of EICHLER) the diagram of *Hippuris* from a Halorrhagidaceae diagram by additions to deduce, because such additions are arbitrary. A certain arbitrariness can probably be accused to most hypotheses, it can nevertheless contain truth. It is to be also considered that the difficulty to

derive the *Hippuris* diagram from the Halorrhagidaceae diagramm is the strong reduction of the *Hippuris* flower and particularly the reason of the position of the stamens before the carpel; it seems to me however that the same difficulty must arise, if one tries to derive this diagram from possibly another type.

The most important reason, which SCHINDLER states against the relationship with the Halorrhagidaceae, seems to be the deviating construction of the ovule, since this is indicated as naked. He probably finds even because of this characteristic a relationship with the Santalales (SCHINDLER 1905). Unfortunately it could be been deceptive here by data of older authors, and has survey that that mistake was disproved by a newer investigation. SCHLEIDEN (1839) might have been the first to have examined the ovule of *Hippuris*, and he described it as integumentless. UNGER (1849) and PIT (1850) also so described it. On the other hand HOFFMEISTER, whom SCHINDLER states also as an authority, so far stated, over this point I could find no investigations of this. EICHLER however (1878) illustrates this ovule with an integument. An exact investigation on its history of the development A. FISCHER (1880) finally supplied, who showed that the small nucellus is composed of a only one strong integument. That his data and illustrations are applicable, I can confirm by my own investigations.

Since Halorrhagidaceae might have generally two integuments, then appears that the ovule of *Hippuris* rather seems to supply a reason against a relationship with this family, even if it is to be noticed that fluctuations in this relationship can seem to occur occasionally within a family, e.g. Ranunculaceae.

A comparison between *Cynomorium* and *Hippuris* regarding the ovule gives the following result (Fig. 1-3). Both genera have a only one, hanging ovule, which in recent developmental stages has a rather small nucellus and a only one, thick integument. With *Cynomorium* the edges of the integuments grow together intimately, so that the micropyle disappears perfectly. With *Hippuris* indeed the micropyle seems to have completely disappeared during a certain stage, then it steps out however again and remains after fertilization for a long time.

The differences in these ovules are, however, quite many. With *Hippuris* the ovule is perfectly allatropous, with *Cynomorium* nearly atropous, so that the micropylar region is arranged inclined downward. With *Hippuris* the integument is strongly extended, short with *Cynomorium* much above the nucellus. The apical part of the nucellus extends with *Hippuris* to a conical body (n), which remains for a long time, while it is in all other respects very soon obliterated. With *Cynomorium* the nucellar apex does not experience increase, its middle and basal part closes up against it very substantially and forms a very much expanded tissue (n), which is displaced later by the endosperm; the integument remains thereby. With *Hippuris* it is the integument, which is absorbed with creation of the endosperm. *Cynomorium* thus does not have a seed coat, *Hippuris* has none, if not a thin, amorphous skin, which takes its place, if one wants to designate it as such.

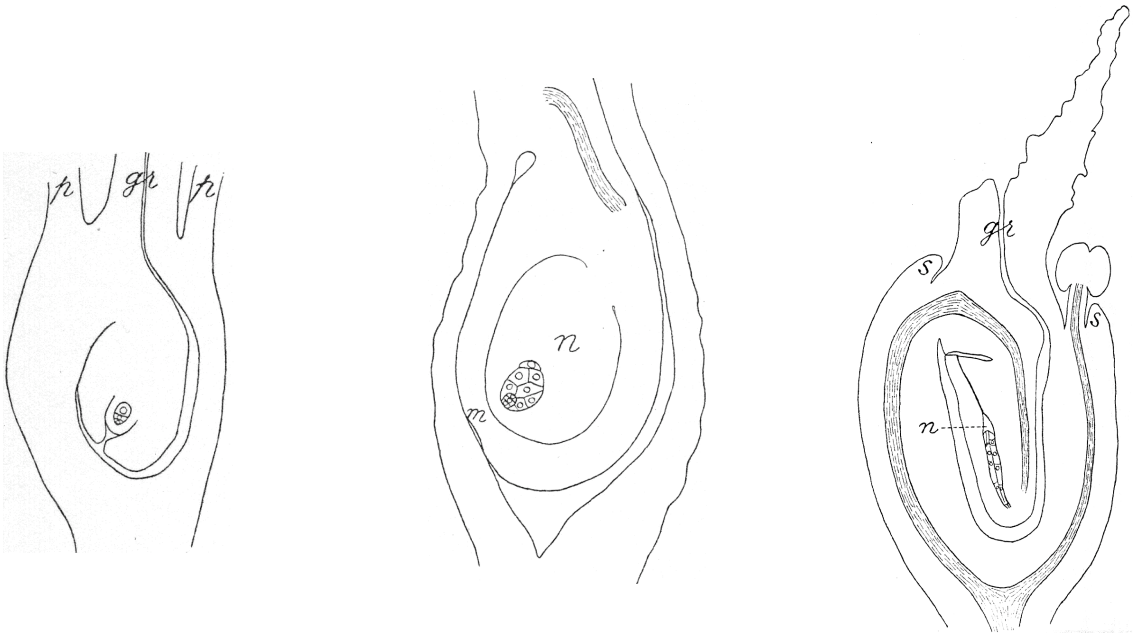

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Fig. 1. Median profile of a young *Cynomorium* flower. Tetrad in the nucellus, micropyle still open. p = perigone, gr = style.
Fig. 2 Median profile of an older *Cynomorium* flower, with embryos and young endosperm, with closed micropyle. n = nucellus, m = micropylar region.
Fig. 3. Median profile (female) of a *Hippuris* flower, with embryos and applied endosperm. gr = stylus, S = perigone seam, n = nucellar apex.

Before I leave the ovule of *Hippuris*, I want to still touch on a few points on its construction. Their micropyles are hidden under the funiculus, it is thus apotropous (which in a sense AGARDH'S also correctly gave). Apotropous are by the way also the ovules of *Myriophyllum.* Extremely strong extension integuments with *Hippuris* (Fig. 3) only partially thereby explained that the embryosack later, while the endosperm origin will extend considerably, the meaning of it only explained by the germinating process. As RETZIUS (1783) already observed, and then TULASNE (1849) well described and beautifully illustrated, with germination in the upper end of the fruit a plug is discharged. This belonged, however, which TULASNE does not accept as the pericarp, but to the upper, lignified part of the ovule. The upper, horizontal, part of the fruit wall do not have a lignified layer.

In relation to the differences in the construction of the ovules of *Cynomorium* and *Hippuris*, the common characteristics seem to be not important enough, in order to supply proof of a relationship between the two genera. We turn now to the examination of the remaining morphological characteristics.

The perigone leaves are epigynous in *Cynomorium*, they rise however from the ovary at a somewhat different height. Their number changes, perhaps the typical number is five, however they can increase up to eight or be reduced to one. The perigone leaves are narrowly and completely free from each other. This perigone, with which neither the number nor the whorled condition are fixed, seems to belong to a low type, probably not developed by reduction from a double perigone.

With *Hippuris* the shallow seam (Fig. 3 s), which crowns the ovary, is picked up as the remainder of strongly reduced perigone whorls. It is not divided into sections, and the vascular bundle processes also give no explanation in this relationship, because the seam does not receive a vascular bundle. It must have come out, however, from a pronounced whorl, and the members of this whorl must have grown together with each other or be at least so broad that they touched each other at their edges. This whorl corresponds to outside circles of a double perigone.

In order to compare the diagrams and the vascular bundle processes of *Cynomorium* and *Hippuris* flowers with each other, we must know first how the flower is oriented with respect to the subtending axil of *Cynomorium*. This is indicated as follows by WEDDELL (p. 294): "la cannelure du style se trouve assez constamment dirige vers l'axe de la cyme dont la fleur depend. Cette position peut varier un peu par suite de la compression operee par les parties voisines; mais ce n'est qu'un cas tout accidentel" [“the groove of the style is rather constantly directed towards the axis of the cyme of which the flower depends. This position can vary a little in consequence of compression operated by the close parts; but it is only one very accidental case”] The accompanying diagrams (Fig. 4-6) are oriented in the same direction in accordance with this indication. The insertion of the ovule is in both genera the same. The place of the stamens is in contrast different, with *Cynomorium* from the subtending axil, with *Hippuris* advanced to the bract [? Tragblatt]. The circumstance that both genera possess only one stamen, cannot be a proof for a relationship, since these stamens do not correspond to each other.

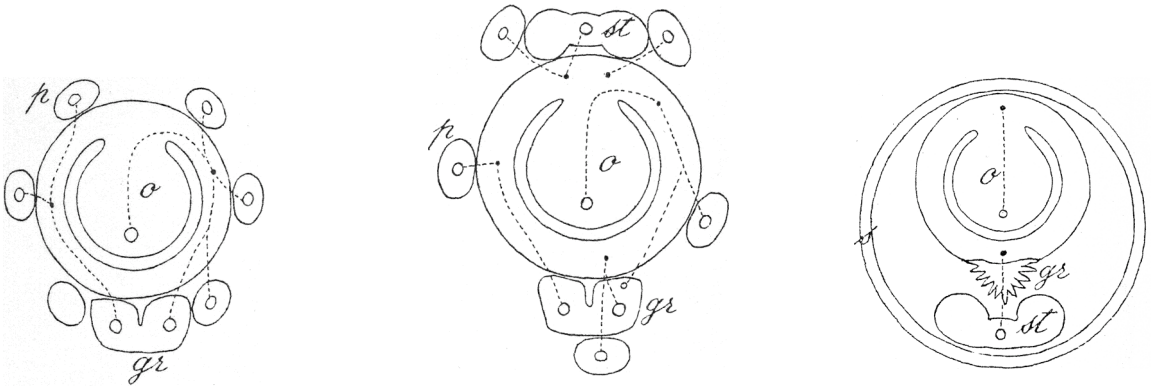

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Fig. 4. Diagram of a female flower of *Cynomorium*.
Fig. 5. Diagram of a hermaphroditic flower of *Cynomorium*.
Fig. 6. Diagram of a *Hippuris* flower.
p = perigone, s= perigone seam, st=stamen, gr=style, o = ovule. The points mark the situation of the vascular bundle in the lower part of the flower, the broken lines indicate their ramifications, the circles their final situation.

The vascular bundle process is very constant and very simple with *Hippuris* (Fig. 3 and 6). A bundle steps into the floral base inside, however, divides immediately into two branches, which run into the ovary at the median level, in front and in the back. The front one goes to the stamen. The rear goes in a large arch to the chalaza. At the summit of the arch it makes, however, an angle, so that it looks nearly in such a way, as if it wanted to deliver here a branch upward. Such an abortive branch could be foreseen for a second stamen or for the style, something that cannot be decided. The style does not receive a vascular bundle. It carries only on the front side a

stigma, but at the base it is all around equal strongly developed (Fig. 3 gr), and it does not seem to me improbable that on the rear part of the style a stigma-bearing section aborts. The vascular bundle process does not at least stand posed in contradiction with the acceptance of two median carpels.

With *Cynomorium* the vascular bundle process seems to be far less fixed. I represented diagrammatically here two examples, an hermophroditic and a female flower (Fig. 5 and 4). That one has these in the basal part of the flower five, only two bundles transverse placed. The ramifications of the bundles might come out from the diagrams. I want to only emphasize that a lateral bundle here sends the branch to the ovule, and that also the style is supplied with vascular bundles at least partially by lateral bundles. These conditions could thereupon be interpreted that the gynoecium is here formed from two (posed) transverse carpels. Without putting to much value on this, I want to only stress that the diagrams of *Cynomorium* and *Hippuris* agree very little among themselves.

I cannot in words draw a positive conclusion over the systematic position of the two genera from these considerations. Concerning *Hippuris*, a strict proof then for its position in the number of the Choripetalae seems to me to so far be missing. As FISCHER (p. 117) emphasizes, follows completely oaks and the Gamopetalae, and who used a uniform perigone seam also as reason for a relationship with this subclass. Under the Choripetalae, where it is nevertheless advisable one should let it provisionally remain, it seems to me, which ENGLER instructs it to be, the most suitable place: as a special family, next related to the Halorrhagidaceae.

Concerning *Cynomorium*, then I believe by the above representation to have proven that the assumed relationship with *Hippuris* is based on weak reasons and is not confirmed by a more exact analysis of the facts. *Cynomorium* seems to me to be quite a genus *insertae sedis*. If one places this genus in the Myrtiflorae, it gets a place too high in the system. PIROTTA and LONGO (1900, p. 114) also rightly emphasized that their characters refer rather to rudiments via reduction. I would prefer to leave it provisionally in the proximity of the Balanophoreae. By its parasite nature and its habit it would at least cut less against these far neighbours, than against the Myrtiflorae.

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