ON THE SYSTEMATIC POSITION OF HEMITRAPA AND SOME OTHER FOSSIL TRAPA

SHIGERU MIKI
Osaka City University, Osaka, Japan

Generally speaking, the stems or leaves of aquatic plants, because of their flaccidity, are seldom preserved, while their nuts, being solid and durable, often remain fossilized. The observation of the existing Ceratophyllum, Trapa and Trapella shows that although they have quite different systematic positions, their nuts apparently resemble one another closely, with shapes like spindles or eggs and with single chambers and with spines or appendages. In the case of remains consisting chiefly of nuts, therefore, it is hardly possible to determine their systematic positions, unless their morphological aspects are fully examined and considered. The ancient plants of Hemitrapa trapelloidea, Trapa borealis, Trapa Yokoyamae, Trapa sachalinensis and Trapa hokkaidoensis have, thus, peculiarities different from those of Trapa, and although similarly shaped to Trapella of Gamopetalae in some respects, yet they can hardly be said to be of quite the same form. The conclusion, therefore, is that they all should be given the same systematic position as Hemitrapa, and that, together with Trapella, they should be included within the family of Trapellaceae. Particulars in this connection are as follows.

HEMITRAPA

In 1941, a lot of remains belonging to this genus were discovered, in the Pinus trifolia beds developed at Seto (Aichi Pref. in Japan) and Tajimi (Gihu Pref. in Japan) areas (Text-Fig. 1). Spindle-shaped, they closely resemble in appearance Trapa borealis, well known in the form of fossils, and yet are different from the same because there are brushes of inflected bristles on the elongated appendages of the receptacle as often seen on the horns of the nut of the existing Trapa. They are different, too, from Trapella, inasmuch as they each have a perigynous receptacle which is not placed above the ovary, along with another distinction, in that the appendages are not the secondary growths of the bract but the mere extensions of the receptacle tips. Again, they can be distinguished from Trapa by the fact that in their case the receptacle is bowl-shaped with no horns, and that the brushy hairs are more slender, growing out of the top of the nut. Such being the case, there are no existing plants which are similar to them, for which reason the writer in 1941 referred them to a hitherto unknown genus of Hemitrapa.

Special Features—As compared with the existing Trapa, the remains of Hemitrapa show the following peculiarities (see Text-Fig. 2):

1. The part of the nut wrapped up by the receptacle is more or less of the same size as its uncovered top.
2. The brushy hairs on the top of the nut grow out of no apical crown of particular shape.
3. The appendages are in contrast to those of the existing Trapa, which have their right and left horns and front and rear ones

Text-Fig. 1 — Hemitrapa trapelloidea Miki (collected from Seto and Tajimi in Japan). Scales in mm.
grown on the same plane, and they are not
fit for the protection of the nut.
4. The receptacle is bowl-shaped with
peduncles, and the entire nut is somewhat
spindle-shaped, curving somewhat like an arc.

As compared with Trapella, however,
Hemitrapa has the following similarities:

1. Provided with peduncles, the entire
nut is spindle-shaped but curves like an arc.
2. The nut has a well-developed receptacle,
and the brushy hairs on its top grow
out of no apical crown.

As stated above, the perianth is developed
from the periphery of the nut, which, in
comparison with Trapa whose perianth is
placed lower, shows a more evolved form.
Again, judging the embryo from the form
of the nut, it can be concluded to be
quite unlike that of Trapa which stores
nourishment in a large cotyledon. This is
fully proved by the fact that the part of the
nut wrapped up by the receptacle is equal
in size to its upper part in which the stem of
embryo is contained. The conclusion, there-
fore, is that, just as in the case of Trapella,
the form of the nut is a good reflection of a
well-developed stem of the embryo. It is
also noticeable that the nut of Hemitrapa
seems to have matured with its upper part
down after post-floral movement, as is often
seen in many aquatic plants and those
belonging to Solanaceae.

Habitat — The nut of Hemitrapa consists of
a single chamber which does not split open.
Its coat is about 1 mm, thick with no particu-
lar protection. Besides, the stem of its
embryo is rather thick. All these things
being the peculiarities of the aquatic plants
in general, it is clear that Hemitrapa belongs
to one of them.

Affinities — There are points of distinction
between Hemitrapa and Trapa; for instance,
the forms of the embryos, position of perian-
th, non-existence of apical crown in the
former, and so on. This, therefore, makes it
almost impossible to presume affinity between
these two. But, as compared with Trapella,
it has many peculiarities in common: the
forms of the embryos, non-existence of apical
crowns, possession of peduncles, curving of
nuts, etc. For these reasons, it is clearly
more appropriate to seek affinity with Trap-
elia than with Trapa.

OTHER FOSSILS WITH SIMILAR
PECULIARITIES

Of the fossils of spindle-shaped and
somewhat curved nuts with peduncles and
bowl-shaped receptacles, but with no parti-
cular apical crowns, the following four have
hitherto been reported as belonging to the
genus of Trapa: Trapaborealis Heer, Trapa
Yokoyamae Nathorst, Trapasachalinensis
Okutsu and Trapahokkaidensis Okutsu.
Their peculiarities, as compared with the
genera of Trapa, Hemitrapa and Trapella,
are shown in the following table:

<table>
<thead>
<tr>
<th>GENUS AND SPECIES</th>
<th>APICAL CROWN</th>
<th>FORM OF EMBRYO, ESP. SIZE OF COTYLEDON AND STEM OF EMBRYO</th>
<th>FORM OF NUT</th>
<th>CURVING OF NUT</th>
<th>ANGLE FORMED BY APPENDAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trapa</td>
<td></td>
<td>&lt;Col</td>
<td>Inverted egg</td>
<td>—</td>
<td>90°</td>
</tr>
<tr>
<td>Trapella</td>
<td>—</td>
<td>Stem &gt;</td>
<td>Spindle</td>
<td>+</td>
<td>90°</td>
</tr>
<tr>
<td>Hemitrapa</td>
<td>—</td>
<td>—</td>
<td>Spindle</td>
<td>+</td>
<td>30°-40°</td>
</tr>
<tr>
<td>Trapaborealis</td>
<td>—</td>
<td>—</td>
<td>Spindle</td>
<td>+</td>
<td>30°-40°</td>
</tr>
<tr>
<td>Trapayokoyamae</td>
<td>—</td>
<td>—</td>
<td>Expanded egg</td>
<td>+</td>
<td>60°</td>
</tr>
</tbody>
</table>
| Trapa sachi-
| linensis        | —            | —                                                       | Spindle     | +              | 50°                     |
| Trapahokkaido-
| nensis          | —            | —                                                       | Spindle     | +              | 40°                     |

As shown above, these fossils come very
near to Trapella and Hemitrapa in regard to
their growth of hairs, the form and curves
of the nuts and the morphological aspects
of the embryos. It is true that appearances
alone are not sufficient to allow us to deter-
mine whether their appendages such as spine
and horns are the mere extensions of recep-
tacles, as in the case of Hemitrapa, or the
secondary growth of bracts as Trapella, but
the former presumption is not impossible,
because appendages do not form a right
angle in each case. Thus, they have very
little in common with Trapa, and resemble
Trapella and Hemitrapa far more closely.
Especially, they come nearer to Hemitrapa
than to Trapella with regard to the position
of their perianths, forms of their appendages
and so forth. Hence, the appropriateness
of classifying them as belonging to Hemitrapa.
**Hemitrapa borealis** Miki comb. n. Fig. 2 F
Syn. *Trapa borealis* Heer (1869) Taf. 8, f. 9-11 (except 11)
Nub ovate: 28 mm. high, 10 mm. wide, appendages 2.
At a glance the remains seem as deformed *Trapa incisa* S. & Z. which is inverted, as shown in Fig. 2 C (b, c), but it differs in the existence of a well-developed brushy haired part and by having peduncles, which characteristics correspond to those of *Hemitrapa*.
The species differs from *Hemitrapa trapelloidea* by having fewer robust appendages.

**Hemitrapa Yokoyamae** Miki comb. n. Fig. 2 G
Syn. *Trapa Yokoyamae* Nathorst (1888) Taf. 7, f. 6-8
Nub broadly ovate: 30-40 mm. high, 20 mm. wide, curved, appendages 4.
Nub differs from *Trapa* by being curved with a well-developed brushy haired part and delicate appendages.
The species may be distinguished from other species by large broad nuts.

**Hemitrapa sachalinensis** Miki comb. n. Fig. 2 H
Syn. *Trapa sachalinensis* Okutsu (1939) Geol. Soc. Japan 46, 328, Fig. 1
Nub longer spindle: 50-60 mm. high, 12-15 mm. broad, appendages 4.
The species may be distinguished from other species by longer nuts.

**Hemitrapa hokkaidoensis** Miki comb. n. Fig. 2 I
Syn. *Trapa hokkaidoensis* Okutsu (1939) Geol. Soc. Japan 46, 329, Fig. 2
Nub 45 mm. long, 10 mm. wide, appendages 4.
The nut seems as if it were a form of *Hemitrapa trapelloidea* (Fig. 1) or *Trapa silesiaca* Göpp. (Fig. 2 B) but it differs from the former by four appendages and from the latter by a well-developed apical brushy haired part, though without any apical crown.

Keys regarding *Hemitrapa*:
1. Nut with thread-like appendages
   (a) Appendages 4, incomplete regarding terminal parts — *H. hokkaidoensis*
   (b) Appendages numerous, the longer ones of which have brushes of inflected bristles on the top — *H. trapelloidea*
2. Nut with somewhat robust appendages
   (a) Nut broadly ovate, 20 mm. wide — *H. Yokoyamae*
   (b) Nut spindle shaped, 10 mm. wide
       (i) Appendages long — *H. hokkaidoensis*
       (ii) Appendages short — *H. borealis*

**Distribution**
The remains of *Hemitrapa* have been found in the early Tertiary strata of America and Asia but not in Europe (GAMS, 1927). As pointed out by Kryshtofovich, this is probably due to the fact that the temperate parts of Asia have a climate quite different from that of Europe. It is to be presumed, therefore, that this small aquatic plant did not grow in the aforesaid regions of Europe.

**Systematic Position**

*Hemitrapa* has a close relation to *Trapella* as stated above. *Trapella* was classified as belonging to the family of Pedaliaceae, but in the case of Pedaliaceae there are no instances of well-developed receptacles and nut which matures upside down, besides the distinction regarding ovaries which are single chambered and placed lower. Again, as compared with the family of Acanthaceae which have closely resembling flowers and well-developed receptacles, and which in many cases grow in water or marshy places, distinctions can be noticed with respect to the absence of crystalloids, forms of pollen and methods of seed discharge. Like *Trapella* and *Hemitrapa*, *Solanum* has its fruit grown upside down, but the distinction is that it has symmetrical flowers and fewer seeds.

Thus, the existence of plentiful remains of ancient plants resembling *Trapella* proves that many such plants used to grow in abundance in remote ages. And from the viewpoint of palaeobotany, the writer deems that there are valid reasons for establishing a new family of Trapellaceae (this is also the opinion of Dr. Honda) instead of including them in the family of Pedaliaceae as Oliver does.

**Summary**

1. *Hemitrapa* has peduncles, bowl-shaped receptacles and inconspicuous horns with no apical crown on the top of its spindle-shaped receptacles — peculiarities which *Trapella* shares but which *Trapa* does not. Yet, it is different from *Trapella*, too. There are such
remarkable distinctions as are seen in the possession of receptacles growing directly from the periphery of the nut and of appendages of mixed length, the longer ones of which are provided with brushes of inflected bristles; hence the appropriateness of establishing a new genus.

2. The four species of *Trapa borealis*, *Trapa Yokoyamae*, *Trapa sachalinensis* and *Trapa hokkaidoensis* have also nuts, of either spindle or expanded-egg shapes and with no apical crowns; besides, they have their right and left appendages and front and rear ones grown on the same plane. These being the peculiarities of *Hemitrapa*, the writer re-classifies them as belonging to *Hemitrapa*.

3. Both *Trapella* and *Hemitrapa* belong to *Trapellaceae* because there existed many extinct plants with many common characteristics not corresponding to those of *Pedaliaceae* and *Acanthaceae*.

REFERENCES


