

A Pleistocene Nymphalid Butterfly from Shiobara, Japan

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Introduction

This article deals with the second record of fossil butterfly from the Pleistocene deposit of Shiobara Fossil Lake, Tochigi Prefecture, Japan. From the same locality, the author (1968) has reported an occurrence of *Papilio maakii*, a swallow-tail butterfly.

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Geologic Age of Shiobara Group

The geologic age of the Shiobara Group has been designated to Early or Middle Pleistocene without positive evidence to determine the precise age, because the distribution of the group is isolated from the contemporaneous strata.

YAMAZAKI (1975) has given several dates of the Shiobara Group, about 30,000 years old by radiocarbon method. These dates are too young compared to the age expected by many geologists and paleontologists. The author asked additional datings to Japanese Radioisotope Association in 1979 and 1981, and the results are as follows:

- a. N-3304 >37,800 y. B.P. (1979)
- b. N-3305 >37,800 y. B.P. (1979)
- c. N-4340 >37,800 y. B.P. (1981)

The materials of a and c are somewhat carbonized wood dug up from the mudstone of the Akagawa Formation at a small cliff of Nakayama, which is perhaps the same point as Locality 4 of YAMAZAKI (1975). That of b is the depressed and somewhat carbonized wood occurred associated with fossil leaves and insects from the Miyajima Formation at the Shiobara Fossil Plant Garden.

The above dates of the Shiobara Group are outside the limit of measurement by radiocarbon method (37,800 years old), while dates of YAMAZAKI (1975) are younger, ranging from 28,000 y. B.P. to 33,600 y. B.P. Considering all over, the author prefers the older ages.

Some cold climatic elements among the fossil leaves from the group are suggestive

of the influence of a certain ice age (ENDO, 1935, and others). On the other hand, the fossil spider indicating rather warm climate has been found in the group. Thus, detailed floral analyses of every horizon of the fossil bearing strata are required.

The definite geologic age of the Shiobara Group remains undetermined, though the author thinks at present that the Middle Pleistocene is most probable as the age of the group.

Fossil Nymphalid Butterfly

Hestina japonica (C. et R. FELDER), 1862
(Japanese name "Gomadara-chô")

(Pl. 1, fig. 1)

Specimen examined: Collected at the Shiobara Fossil Plant Garden, Shiobara, Tochigi Prefecture, Japan. Miyajima Formation, Shiobara Group, Early or Middle Pleistocene. Deposited at the Department of Paleontology, National Science Museum, Tokyo, reg. no. NSM-PA12228.

Description and identification: A proximal half of left forewing, except its basal part, is preserved. The wing venation and the remaining markings are characteristic of Apaturid group in nymphalid butterflies. Among a great number of butterflies living in Japan and the adjacent areas, *Hestina japonica* is a corresponding species to the fossil specimen.

The specimen shows the upper surface of left forewing, so the wing veins are thickly impressed. The venation is characteristic especially in the discoidal cell, which is distally open and bears no veinlet nor trace to close the cell between veins 4 and 5. Veins 3 and 4 diverge far beyond the diverging point of veins 5 and 6. Vein 5 arises on vein 6 and is hook-shaped at the base. Veins 5 and 6 run subparallel. Veins 1, 2, and 3 run straight and parallel. Several large white patches and streak on the fossil forewing correspond well to those on the membrane of *Hestina japonica*. The marking on the membrane of *Hestina japonica*, which is revealed by stripping off scales, is only slightly large than the apparent marking represented by scales (Pl. 1, figs. 2, 3).

As far as the remaining features of the fossil are compared with living ones, the fossil specimens is reasonably assigned to the living species *Hestina japonica* (= *Diagora japonica*). No other species closer to the fossil specimen are found among the living nymphalids.

Comparison with Local Races and Seasonal Forms of Living *Hestina japonica*

Hestina japonica was first described based on the specimens from Japan by C. and R. FELDER in 1862 as *Apatura japonica*. Subsequently this species was occasionally placed under the genera *Diadema*, *Euripus* and *Hestina*. In 1894 the genus *Diagora* was erected for this species by SNELLEN, but later this genus was synonymized

with the genus *Hestina* as the reason for separating the genus from *Hestina* was insufficient (STICHEL, 1938; ESAKI & SHIRÔZU, 1951).

In Japan, this butterfly emerges twice a year (occasionally thrice), the spring form is named f. vern. *australis* and the summer form f. aest. *japonica*. The former is larger in size and bears broader wings with larger white patches than the summer form in general.

Hestina japonica japonica is distributed throughout the mainland of Japan from Hokkaido to Kyûshû. In Hokkaido, its habitat is limited to the southwest part, south of Sapporo, and it is rather seldom. Those from Central and Southern Korea (subspecies *seoki* SHIRÔZU), from West and Central China (subspecies *chinensis* LEECH) and from Taiwan (subspecies *manja* FRUHSTOFER) are distinguished from the nominate race as subspecies. SHIRÔZU (1955) made clear the differences between those local races. Summer brood of Korean subspecies is distinguishable from the Japanese race in the following features of forewing: (1) narrower wing shape and more produced apex, (2) linear and more distally extended basal white patch on the cell, (3) well-developed and swollen basal white streak in space 1. The Korean subspecies is more closely related to the Chinese race, but the latter differs in more developed basal white patches both in the cell and space 1 and more prominent white spots of marginal and submarginal series. Spring brood of the Korean race bears wings with so extremely reduced black portion that it is mistaken for other species than *Hestina japonica*. The specimens from Tsushima, an island lying between Japan and Korea, show an intermediate appearance in its summer brood. The Chinese race, *japonica chinensis*, has the smaller but prominent white patches and streaks on the forewing than of the subspecies *japonica*. However, the specimens from China (Pl. 2, figs. 4, 5 and 6) other than the type specimen figured by LEECH (1892) (Pl. 2, fig. 7), differs so scarcely that they are impossible to be distinguished from the Korean race *seoki*.

Size of wing: For the comparison of wing size with the fossil specimen, 110 specimens of *Hestina japonica* from Japan excluding Hokkaido, 11 specimens from Hokkaido, 8 from Korea and 3 from China, were measured. The distance between veins 1 and 2 measured near the basal part of vein 2 was used for the comparison of wing size, as the values roughly indicate the size of wing although they are not always proportional. The measured values range from 3.80 to 5.15 mm (average value 4.42 mm) in 81 specimens of the spring brood of Japan, from 3.80 to 4.85 mm (average value 4.28 mm) in 30 of the summer brood. It is distinct that large-sized individuals of the summer brood are very scarce.

The value measured on the fossil wing is 5.10 mm, corresponding to the largest individual of the spring brood among 110 examples. The measured value on 11 materials from Hokkaido do not exceed 4.50 mm. *H. seoki* from Korea, being 3.90–4.50 mm in spring brood (4 individuals) and 3.85–4.25 mm in summer brood (4 individuals), is too small to be compared with the fossil material. Also, *H. japonica chinensis* from China is 4.00–4.65 mm. LEECH (1892) mentioned that *chinensis* 76–80 mm and “*australis*” from Japan is 96–108 mm in expanse, but the present

author has never seen such large-sized individuals in f. vern. *australis*. The largest individual among 110 specimens examined by him is measured 87 mm in expanse.

Wing-shape: The fossil wing is broad just like the female of the Japanese race, unlike the Korean race with narrow forewings.

The summer brood of the Japanese race bears narrower forewings than the spring brood, except some females. Specimens from Hokkaido emerging once a year, are small-sized and like the summer form of the main islands of Japan other than Hokkaido, in size, wing-shape and other characters.

Basal patch on cell: The basal white patch on the discoidal cell of the fossil is long and extended distally. In *H. japonica japonica*, the distinct patch on the cell appears only in summer forms and in some of the female of spring brood, otherwise they are one or a pair of faint streak.

The conspicuous white patch of the Japanese race is of short triangle truncated distally, unlike long triangular patch of the Korean race. That of the present fossil seems to be elongate distally like those of the Korean race.

Streak in space 1: The streak in the space 1 of the fossil is too much swollen for the Japanese race rather like the Korean race. It is not extended beyond the white patch in space 2.

Patch in space 2: The white patch in space 2 of the fossil is not so elongate distally as seen in most female specimens of *japonica* s.s.; some male materials show a short patch like the fossil. In the fossil the patch is situated at a short distance from the base of vein 3, not beyond the base of vein 3 as in most of recent specimens.

Conclusion

Judging from the above-mentioned features, the fossil undoubtedly belongs to *Hestina japonica* and probably to the spring brood of the Japanese race *japonica* s.s. However, it does not entirely correspond to *japonica* s.s. It is noteworthy that the fossil has some features of wing markings like the summer form of the Korean race *seoki* or Chinese race *chinensis*, in spite of the affinity to the Japanese race in size and shape of their wings.

The fossil *Hestina japonica* corresponds to the spring form of Honshu in size, not to the specimens from Hokkaido of one brood a year. It suggests rather temperate climate in that time when the present fossil *Hestina* subsisted.

As a result of comparisons of the fossil with the living local races and seasonal forms of *Hestina japonica*, the following assumption may be drawn, although other suppositions may be possible: in a geologic age, the ancestral race of *H. japonica* came from the Chinese Continent to Japan through East China Sea, which was the extent of the continent at that time, or through the central or southern Korea, and spread its habitat into Japanese Islands.

The temperate and humid climate of Japan especially in winter caused this butterfly the enlargement of size and the cease of the reduction of black portion on wings

(albinism of wings) in spring form (occasionally it appears in some degree in hind wings of spring brood as shown in Fig. 5 of Plate 1). However, the fossil specimen had still retained white markings on wings like the Chinese or Korean races, thereafter the white markings of the Japanese race have changed to be like the present one.

If the precise ages when *Hestina japonica* settled in Japanese Islands and when the present fossil lived there (the geologic age of Shiobara Fossil Lake) are identified, this fossil would offer a clue to estimate the duration during which a subspecies of butterfly is established.

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Explantation of Plates

Plate 1

(1-3: $\times 1.5$; 4-7: $\times 1$)

1. *Hestina japonica* (FELDER). Pleistocene fossil, Shiobara, NSM-PA12228.
- 2a. *Hestina japonica japonica* (FELDER), f. vern. Left forewing.
- 2b. Ditto, stripped off scales.
- 3a. *Hestina japonica japonica* (FELDER), f. aest. Left forewing, same specimen as fig. 6.
- 3b. Ditto, stripped off scales.
4. *Hestina japonica japonica* (FELDER) ♂, f. vern. Saga, May 21, 1916.
5. *Hestina japonica japonica* (FELDER) ♀, f. vern. Tokyo, June 2, 1938.
6. *Hestina japonica japonica* (FELDER) ♂, f. aest. Tokyo.
7. *Hestina japonica japonica* (FELDER) ♀, f. aest. Tokyo, Sept. 2, 1948.

Plate 2

(all figures: $\times 1$)

1. *Hestina japonica seoki* SHIRÔZU ♂, f. vern. "Hakuyozan", southern Korea, May 25, 1939.
2. *Hestina japonica seoki* SHIRÔZU ♂, f. aest. Kwangneung, central Korea, Aug. 9, 1962.
3. *Hestina japonica seoki* SHIRÔZU ♀, f. aest. Taegue, southern Korea, Sept. 1, 1916.
4. *Hestina japonica chinensis* LEECH ♂, f. vern. Omei-shan, West China.
5. *Hestina japonica chinensis* LEECH ♂, f. aest. Omei-shan, West China.
6. *Hestina japonica chinensis* LEECH ♂, f. aest. Kang-ting, Su-chuan, West China, Aug. 22-26, 1980.
7. *Hestina japonica chinensis* LEECH, f. aest. Figure of type specimen after LEECH (1892).



