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211
WITH THE AUTHOR'S COMPLIMENT

FOSSILS FROM SINGAPORE.

R. BULEEN NEWTON, FGS

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NOTICE OF SOME FOSSILS FROM SINGAPORE DISCOVERED BY
JOHN B. SCRIVENOR, F.G.S., GEOLOGIST TO THE FEDERATED
MALAY STATES.

By R. BULLEN NEWTON, F.G.S.,

of the Department of Geology, British Museum (Nat. Hist.), Cromwell Road, S.W.

(PLATE XXV.)

Introduction.

AS representing the first fossils yet recorded from Singapore, these specimens are of considerable interest. They principally consist of marine Lamellibranch remains accompanied by an obscure indeterminable Gasteropod, and a few fragmentary terrestrial plants. Their condition, however, as casts and impressions renders them most difficult to work out satisfactorily, more especially the shells where only external features of the valves are available for study. Some of the specimens, however, retain certain points of structure or contour which appear to have an important bearing on their probable geological age. The association of land and marine organisms would at once suggest an estuarine or lagoon origin for the beds containing them, more especially as the mollusca belong to genera or families which may be regarded as of shallow-water habit, whilst the plant-remains might be accounted for by the close proximity of land or the transporting agency of river action. Among the shells, that referred to *Goniomya* is of chief interest, since it belongs almost exclusively to the Mesozoic period, being particularly characteristic of Jurassic rocks and of much rarer occurrence in deposits of Cretaceous age.

Although exceedingly rare, *Goniomya* has also been found in Palæozoic rocks, Krotow having figured and described *G. Artiensis* from the Russian Permian (Soc. of Naturalists Imp. University of Kasan, 1885, vol. xiii, p. 225, pl. iii, fig. 20), and an unnamed form from rocks of similar age in the Central Himalayas has been more recently recorded by Dr. Carl Diener (Palæontologia Indica,

1903, ser. xv, vol. i, pt. 5, p. 126, pl. v, fig. 19, and p. 176, pl. viii, fig. 11).

The plant structures, although obscure, are also important. A leaf-like body has been referred to *Podozamites* cf. *lanceolatus* (Lindley & Hutton), a genus and species which enjoyed an extensive geographical distribution during the Bajocian stage of Jurassic times, having been recorded from Yorkshire (Haiburn Wyke); Spitzbergen; Orenburg; East Siberia; Astrabad, Persia; India (Upper Gondwana Beds); China; Japan; and Korea.

Podozamites is but one member of a large group of similar plants, generally included under the Cycadaceæ, which were of abundant occurrence in the Mesozoic period, and of which *Williamsonia* may be regarded as the type. Such a flora has been described by Feistmantel as typical of the Upper Gondwana deposits of India, and it is of further interest to note that marine molluscan remains have been also found in some of those beds associated with the plants (R. D. Oldham's edition of Medlicott & Blanford's "A Manual of the Geology of India," 1893, p. 180).

The Singapore Clays, therefore, with their estuarine contents, may be of Middle Jurassic age, and about the horizon of the Inferior Oolite of England or the so-called Bajocian of Continental geologists. They possibly represent an extension or outlier of the Upper Gondwana rocks of India, as well as forming part of the other fossiliferous areas of Eastern Asia, including Korea, Japan, and Siberia, which have yielded a similar vegetation.

Mr. John B. Scrivenor, the discoverer of these fossils, has furnished the following account of the beds and locality, stating that the specimens were obtained "from a 2 ft. (circd) bed of silty clay with obscure plant-remains, forming a part of the series of shale and sandstone beds which embraces all the known sedimentary rocks of Singapore Island apart from surface deposits, and exposed in a big quarry on the north flank of Mount Guthrie, Tanjong Pagar, Singapore Town.

"What remains of Mount Guthrie is likely to disappear before long; in fact, the original hill extended over the spot where I found the fossils. The specimens take some time to collect, as they are sparsely distributed. I send the best fossil leaf I could find and also an object which may be a fruit. I also saw obscure vegetable remains in shale at Tanjong Malang, close by; and at Mount Wallich, also close by, I saw one piece of badly-preserved fossil wood. In the Mount Guthrie quarry, about 50 yards from the fossiliferous horizon, I found a 6 inch seam of very poor brown coal.

"The shale and sandstone series is very highly inclined in this part of Singapore; in one section I saw the beds are vertical. At Mount Guthrie the strike is N.N.W.-S.S.E., the dip about 75° W.S.W.

"The strike and petrological characteristics of the series wherever seen suggest a connection with the shale and sandstone of the Federated Malay States; but, again, were these rocks situated in Sarawak [Borneo] the petrological evidence and the presence of the obscure vegetable remains would not be sufficient alone to separate

them from the shale and sandstone of Upper Sarawak and Santubong " [Borneo].¹

Description of the Fossils.

The matrix containing the fossils is a light drab-coloured compact clay, varying slightly in tint and particularly soft to the touch, marking everything as if it were chalk, although according to the acid test no calcareous constituents are present. Dr. G. T. Prior, of the British Museum, who has examined the material, has detected some minute particles of silica entering into its structure.

The specimens herewith described and figured have been mainly collected by Mr. John B. Scrivenor, although a second series from the same locality and beds was subsequently furnished to the writer by Dr. R. Hanitsch, of the Raffles Museum, Singapore, three of which are represented on the Plate by Figs. 3, 4, and 17. Through the good services of both Mr. Scrivenor and Dr. Hanitsch the specimens selected for illustration have been presented to the British Museum. A word of praise should be extended to the artist, Mr. A. H. Searle, for the excellent drawings he has constructed from obscure and difficult material, and which, thanks to the collotype process, have been satisfactorily reproduced on the Plate.

LAMELLIBRANCHIA.

CUCULLÆA SCRIVENORI, sp. nov. (Pl. XXV, Fig. 12.)

Shell small, compressed, inæquilateral, subquadrate, oblique; umbo very anterior; dorsal margin horizontal, short; anterior area short, deep, obliquely and roundly truncated; posterior region wide, produced, rounded, and bearing an elongate oblique depression, with an angulation at the posterior end of the hinge-line; ventral margin nearly parallel with dorsal line; ornamentation consisting of extremely fine concentric growth-lines crossed by a series of delicate radial striations.

Dimensions.—Length 13, height 7 mm.

The specimen referred to this form is a small, rather compressed right valve, embedded in the rock, and, like the other specimens from this locality, only showing external characters. It appears to differ from previously described forms of this genus by its very inæquilateral character, the umbo being within a small distance of the anterior margin, and the relatively long and narrow posterior depression. The sculpture markings are obscure, but when properly shaded the valve shows decussating striations.

Collector.—Mr. J. B. Scrivenor.

¹ These Borneo Beds have been examined and reported upon by Mr. John B. Scrivenor, and the results issued in a Government paper (No. 8) published at Kuala Lumpur by the Geological Department of the Federated Malay States on the 19th January, 1905, entitled "A Report on the Geology of the Residency of Sarawak, and of the Sadong District, Borneo, with special reference to the occurrence of Gold and Coal."

ARCA sp. (Pl. XXV, Fig. 14.)

Shell narrow, elongate; hinge-line horizontal and parallel with ventral border; umbo depressed, anterior, oblique; carinated obliquely and obtusely from umbonal region to postero-ventral margin; anterior end rounded, posterior truncated, and area depressed; sculpture consisting of very obscure concentric lineations without evidence of radial striae.

Dimensions.—Length 20, height 8 mm.

This description applies to a natural cast of a right valve embedded in the rock showing the external surface. Narrow forms of *Arca* are fairly common in Jurassic deposits, but they are invariably ornamented with radial striation; as no such sculpture exists in the Singapore fossil it may be inferred that none was ever present, although it is possible that the counterpart, which does not appear to have been preserved, might have yielded a better interpretation of the original surface structure.

Collector.—Mr. J. B. Scrivenor.

GERVILLIA HANITSCHI, sp. nov. (Pl. XXV, Fig. 4.)

Shell lanceolate, subcylindrical, curved at ventral margin, moderately convex at carina; anterior area, shortest, with an acute cuneiform termination, narrow and produced posteriorly; umbonal region terminal; dorsal area, constituting a long narrow obliquely striated depression, entirely bordered within by an obtuse carina, and above by an obscure lengthened hinge-line; growth-lines slightly impressed.

Dimensions.—Length 54, height 12 mm.

This interesting specimen consists of a natural cast and counterpart, showing external surface of a left valve, which resembles in many of its characters some Jurassic forms of the genus, such as *G. monotis*, Deslongchamps, from the Bathonian of Britain and Europe, or *G. acuta*, J. de C. Sowerby, of Bajocian age. From the former it appears to differ in its lesser convexity and longer hinge-line, and from the latter in its less oblique and more lengthy hinge area.

Collector.—Dr. Hanitsch.

VOLSELLA cf. *COMPRESSA*, Goldfuss. (Pl. XXV, Fig. 5.)

Mytilus compressus, Goldfuss: Petrefacta Germaniae, 1837, vol. ii, pl. cxxxi, fig. 11, p. 178. Morris & Lycett: Mon. Pal. Soc. (Great Oolite Mollusca, part 2), 1863, pl. iv, fig. 7, p. 40.

In general contour and flatness this shell is closely related to *Mytilus compressus* of Goldfuss, originally described from Hanover and the Stonesfield Slate. The principal distinction appears to be in the concentric lineations, which are fewer and more distant in the Singapore fossils, although some obscure ones are traceable between the more important striae, especially on the lateral areas. The umbo is not terminal as in *Mytilus*, so that this form is recognized as a true *Volsella* (= *Modiola*). The specimen shows an external view of a left valve embedded in matrix.

Dimensions.—Length 20, height (maximum) 10 mm.

Collector.—Mr. J. B. Scrivenor.

? *NUCULANA* sp. (Pl. XXV, Fig. 7.)

A figure has been drawn of a fragmentary valve which may represent either a *Nuculana* or an *Anatina*, that is if the shell can be assumed to have possessed a rostration as indicated by the dotted lines. The specimen shows an external view of a compressed right valve with a short and rounded anterior area and a horizontal dorsal line which forms the boundary to an obtusely angled, elongate area, extending posteriorly from the rather flattened umbonal region. The surface of the valve is delicately striated concentrically, and slightly wrinkled posteriorly.

Supposing the specimen originally to have been rostrated, then the concentric lineation is finer than usually obtains in *Anatina*, being perhaps more applicable to *Nuculana*, although even in that genus the dorsal line appears to be too horizontal, an obliquity being usually apparent descending from the umbo before proceeding in the posterior direction.

Collector.—Mr. J. B. Scrivenor.

? *NUCULOID* SHELL. (Pl. XXV, Fig. 6.)

The "Nuculoid shell" here referred to is an external view of a narrow, lanceolate right valve, buried in the matrix, and preserved as a natural cast together with the counterpart. The umbo is very anterior, small, and scarcely rising above the hinge-line; the dorsal and ventral margins are subparallel; anterior margin short and rounded; posterior oblique, produced, and subacuminate; sculpture consisting of delicate striae of growth, concentrically arranged; no crenulations observable on the hinge area.

Dimensions.—Length 20, height 8 mm.

It is not possible to determine more closely the shell which is here figured and briefly described. Probably it is a form related to *Nucula*, but the absence of crenulations at the hinge area renders such a supposition very doubtful. Further, there is a resemblance in general contour to Conrad's Palaeozoic genus *Nuculites*, the casts of which in common with the specimen from Singapore bears a narrow notch-like cavity in the anterior region beneath the umbo; but, again, the want of cardinal crenulations would create a difficulty if included in such a genus. With better material at some future time this shell may eventually be identified.

Collector.—Mr. J. B. Scrivenor.

? *LUCINA* sp. (Pl. XXV, Fig. 15.)

The specimen referred doubtfully to the genus *Lucina* is a small, subcircular, rather compressed, right valve, showing a nearly mesial rounded umbo directed obliquely forward, and having its surface ornamented with numerous, closely-set, microscopical, concentric striations, which are more obvious on the ventral and lateral areas than on the umbonal region. In the postero-ventral direction the valve is imperfect; this has been indicated in the figure by a dotted line. It is impossible to suggest to what shell this fragmentary valve might be related, although interesting for

reference as one of the species found in the Singapore Clays. This specimen may be also said to resemble some small forms of *Unicardium*.

Dimensions.—Length 11, height 10 mm.

Collector.—Mr. J. B. Scrivenor.

ASTARTE SCRIVENORI, sp. nov. (Pl. XXV, Figs. 11, 12.)

Shell subquadrate, slightly convex; umbo anterior; dorsal line slightly oblique; posterior area depressed, sloping, and angulated below; ventral margin nearly parallel with dorsal; anterior area rounded and short. Ornament consisting of from 10–12 nearly horizontal costal ribs, obtusely angled on both sides, and separated by rather wide sulcations; anterior costæ crowded and finest in front.

Dimensions.—Fig. 11, length 14, height 11 mm.; Fig. 12, length 11, height 7 mm.

This form is represented by two right valves of different ages, the younger showing a much finer and more crowded system of costæ (Fig. 12), whilst the older shell (Fig. 11) possesses a bolder and coarser sculpture. The lateral angles of the costæ present a feature of interest in the sculpture which is apparently not known among typical astartiform shells, hence it has been regarded as a new species. In addition it may be mentioned that this species shows a certain resemblance in contour and structure to *A. interlineata* of Lycett, from the Great Oolite of Minchinhampton (see Mon. Pal. Soc., 1854, pl. ix, figs. 14, 15, p. 87).

Collector.—Mr. J. B. Scrivenor.

ASTARTE GUTHRIENSIS, sp. nov. (Pl. XXV, Fig. 9.)

Shell small, subelliptical, moderately convex; umbo anterior; front area short, rounded, slightly excavated beneath the umbo; posterior margin elongate, oblique; ventral border thickened, rounded; sculpture consisting of about 10 wide, elevated, concentric costæ, bearing minute lineations, divided by smooth sulcations of nearly equal width.

Dimensions.—Length 11, height 6 mm.

This specimen is embedded in the matrix and exhibits an external view of the right valve. The dorso-posterior margin is rather imperfect, otherwise the specimen is fairly seen and its ornamentation is well displayed. The raised concentric and striated ridges divided by the prominent smooth sulcations and without any evidence of radial lines, are the chief sculpture characters of the valve.

Collector.—Mr. J. B. Scrivenor.

ASTARTE GUTHRIENSIS, var. nov. (Pl. XXV, Fig. 10.)

Shell with similar sculpture to *A. Guthriensis*, but of rather quadrate form, and considerably less oblique posteriorly.

Dimensions.—Length 10, height 7 mm.

This variety is represented by an external surface of a right valve in which the umbo is not preserved, but the excavation beneath is well marked.

Collector.—Mr. J. B. Scrivenor.

GONIOMYA SCRIVENORI, sp. nov. (Pl. XXV, Fig. 1.)

Shell narrow, convex, subcylindrical, umbo anterior, vertical, and not prominent; dorsal margin gently sloping from umbo on each side, anterior end rounded, posterior truncated; sculpture consisting of a regular series of about 16 V-shaped, slightly curved, oblique costæ, which are elevated, rounded, funiculate, and divided by prominent sulcations, bearing closely-set, obscure, longitudinal striations; some of the costæ at the anterior end are angulated inwards.

Dimensions.—Length 21, height 7 mm.

This specimen, represented by an external view of a left valve embedded in the clay-matrix, is beautifully marked, the costæ showing a delicate cord-like structure; it is of narrowly elongate form, and appears to differ from all other members of the genus by its non-prominent umbo, the presence of angulate costæ at its anterior end, and the funiculate ornamentation of the costal ribs. The limits of the ventral margin are not defined.

Collector.—Mr. J. B. Scrivenor.

GONIOMYA SINGAPORENSIS, sp. nov. (Pl. XXV, Figs. 2, 3.)

Shell elongate, slightly convex; umbonal region very anterior, obtuse, vertical, slightly elevated at summit; posterior dorsal margin oblique, long; anterior area obliquely margined from the summit, short, rounded; sculpture consisting of a series of V-shaped, sharply angulated costal ribs arranged beneath the umbonal area, separated by sulcations, which are finer and closer on the anterior side and wider apart and divided by broader grooves posteriorly; the ribs are elevated, rounded, and slightly curved outwards; surface of grooves bearing fine longitudinal striations with obscure indications of striae on the anterior costæ.

Dimensions.—Length 32, height (from umbo to thirteenth angulation) 11 mm.

Two out of the three specimens representing this form are shown in Figs. 2 and 3, the former, an excavated impression of a right valve, being the most perfect, though deficient in ventral details; whilst Fig. 3 applies to a fragmentary natural cast of a left valve in which the angulated costæ and the short anterior region are well displayed.

This species differs from *G. Scrivenori* in its more anterior umbo, its much shorter anterior area, more oblique posterior margin, and its less defined ornamentation. It was probably a cylindrical form resembling such a species as Agassiz's *Goniomya sulcata* from the Jurassic rocks of Switzerland, which also possesses very anterior umbones, but differs in having coarser ribbing and a more prominent umbonal area, which is inclined to obliquity. In the absence of dental characters it is impossible to say whether the Singapore specimens might not belong to *Trigonia*, as some forms of that genus exhibit a V-shaped ribbing, such as have been described by Dr. Kitchen from the Oomia Beds (Upper Jurassic) of India (Palæontologia Indica, 1903, ser. ix, vol. iii, p. 70, pls. vii, viii), but

the finer and more regular ornamentation would in any case at once distinguish them from the Indian shells.

Collectors.—Mr. J. B. Scrivenor (Fig. 2) and Dr. Hanitsch (Fig. 3).

? *THRACIA* sp. (Pl. XXV, Fig. 8.)

I have placed doubtfully under the genus *Thracia* the largest of the shell remains found in the Singapore deposits. Unfortunately the umbo is wanting, and its exact position is very uncertain, although it was possibly more or less mesial. The specimen consists of a considerably fractured natural cast representation of the left valve of an elongate shell, rounded anteriorly, with a probably nearly horizontal dorsal margin, and possibly an elliptically curved base. It has the appearance of having had originally an oval outline, and in the posterior region, where the principal characters are merged, there is an obtusely angulated area descending obliquely from the umbonal region to the median angulation of the truncated margin, producing a cuneiformity of outline which is repeated within by the concentric growth-lines.

Dimensions.—Length 62, height (about) 33 mm.

Collector.—Mr. J. B. Scrivenor.

PLANTÆ.

PODOZAMITES cf. *LANCEOLATUS*, Lindley & Hutton.

(Pl. XXV, Figs. 16, 17.)

Zamia lanceolata, Lindley & Hutton: Fossil Flora Great Britain, 1836, vol. iii, pl. 194.

Podozamites lanceolatus, Seward: Catalogue Mesozoic Plants British Museum, The Jurassic Flora (Yorkshire Coast), 1900, p. 242, text-figure No. 44 on p. 245.

H. Yabe: Journ. Coll. Sci. Imp. Univ. Tôkyô, Japan, 1905, vol. xx, Article 8, pl. iv, figs. 4-5, p. 17.

The largest of the two specimens appearing to bear a relationship to *Podozamites lanceolatus* consists of a long leaf-like body embedded in the clay-matrix, much crushed and bent about at its widest end, and diminishing rather rapidly at its other extremity for probable attachment to a rachis, whilst a series of parallel lines or venations traverses the entire surface of the organism. There is no indication of a stem, although the peculiar narrowing of the supposed basal end would suggest that that part would form the point of attachment. The broader end is not complete, so that the original length is uncertain, but the maximum width of the pinna can be given as 16 mm. Although much broader than the pinnae of typical examples, this specimen is by no means the widest known, Dr. Yabe having recently figured some specimens from Korea with a measurement of 20 mm.

The second specimen represents another fragmentary pinna, which is of smaller dimensions, being only 7 mm. wide. It is, however, of interest, since a well-rounded, slightly notched, basal margin can be seen, as well as the characteristic parallel venations, the more lateral of which curve slightly inwards at the termination. Unfortunately the apical region is incomplete, and there is no means of

A. H. Searle, del.

British Museum, London.

ascertaining the exact length of the fossil, although it is probable that it was a much shorter form, such as has been figured by Dr. Yabe from Korea and compared with *P. pulchellus* of Heer from Spitzbergen (Kongl. Svensk. Vetensk.-Akad. Handl. [Stockholm], 1876, vol. xiv, No. 6, p. 38, pl. ix, figs. 10-14). A slight resemblance can also be traced to a pinna recently figured by Mr. Seward from the Stonesfield Slate as *P. Stonesfieldensis* (Catalogue Mesozoic Plants British Museum, Liassic and Oolitic Floras of England, 1904, pl. iii, fig. 4, p. 123), in which a basal notch has been likewise observed.

Remains of this plant are frequently found in a poor state of preservation, and only detached pinnae as a rule are obtained, these being sometimes damaged at their terminations like the Singapore specimens. The species is a very variable one, the pinnae differing considerably in dimensions and the number of parallel venations never being quite the same. Its geographical distribution is extensive. Originally described from the Yorkshire Oolites, it has since been recorded from European countries, Spitzbergen, Siberia, Persia, India (Upper Gondwana Beds), China, Japan, and Korea. For an exhaustive synonymy of the species Mr. Seward's British Museum Catalogue should be consulted.

Collectors.—Mr. J. B. Scrivenor (Fig. 16) and Dr. Hanitsch (Fig. 17).

CARPOLITHES sp. (Pl. XXV, Fig. 18.)

An isolated seed, buried in the matrix, of apparently a Cycadean character has been provisionally referred to the genus *Carpolithes*. It is of rather oblong contour with nearly parallel sides, and bearing a longitudinal rounded ridge on the right margin, which may represent a fractured edge of the outer cuticle of the seed. The central oval and convex body, which is possibly the naked seed itself, is minutely and concentrically striated, especially on the sides.

In connection with the remains of *Podozamites* it is interesting to find a seed of this character in association, as the assemblage is suggestive of a Lower Oolite flora, such as characterise the rocks of the Yorkshire coast, Stonesfield, and the more distant Jurassic regions.

Dimensions.—Width 7, height 8 mm.

Collector.—Mr. J. B. Scrivenor.

EXPLANATION OF PLATE XXV.

FIG.

1. *Goniomya Scrivenori*, sp. nov. External view of a left valve. $\times 2$.
2. *G. Singaporensis*, sp. nov. External view of a right valve drawn from a wax cast of original impression. Nat. size.
3. *G. Singaporensis*. External aspect of a fragmentary left valve. Nat. size.
4. *Gervillia Hanitschi*, sp. nov. External view of natural cast of a left valve. Nat. size.
5. *Volatella cf. compressa*, Goldfuss. External view of a left valve. $\times 2$.
6. [*? Nuculoid* shell.] External view of a right valve, showing obscure anterior notch. Nat. size.
7. *? Nuculana* sp. External view of a right valve, the dotted line showing probable rostration. Nat. size.

FIG.

8. ? *Thracia* sp. Natural cast of an imperfect left valve showing external features. Nat. size.
9. *Astarte Guthrieensis*, sp. nov. External view of right valve. $\times 2$.
10. *A. Guthrieensis*, var. Outer view of a right valve. $\times 2$.
- 11, 12. *A. Scrivenori*, sp. nov. External views of right valves. Fig. 12 drawn from a wax cast of original cavity. Nat. size.
13. *Cucullaea Scrivenori*, sp. nov. External view of right valve. $\times 2$.
14. *Arca* sp. External view of a natural cast of a right valve. Nat. size.
15. ? *Lucina* sp. Outer aspect of a fragmentary right valve. $\times 2$.
16. *Podasamites* cf. *lanceolatus*. An incomplete pinna showing the probable base as tapering to a point where attachment to the rachis might have been effected. Nat. size.
17. *Podasamites* cf. *lanceolatus*. A more imperfect fragment of another pinna with an obscure indication of a basal notch. $\times 2$.
18. *Carpelithes* sp. Longitudinal view of a seed showing on the right margin the remanum of a possible outer integument. $\times 2$.

Note.—Specimens represented by Figs. 3, 4, and 17 were collected and presented to the British Museum by Dr. R. Hanitsch; the remainder were collected by Mr. J. R. Scrivenor and similarly presented by him to the same institution.

A. H. Searle, del.

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