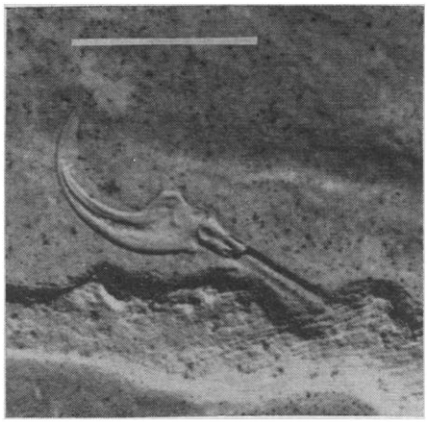

Fig. 2. Greatly enlarged photograph of the terminal phalanx and its horny sheath, digit 3, left manus. The scale is 10 mm long.

poorly preserved specimen recognized in 1956 and now displayed in Solnhofen. The extreme rarity, as well as the unusual evolutionary significance of *Archaeopteryx* specimens, makes the present discovery noteworthy.

The "new" specimen was found 8 September 1970 on display in the Teyler Museum, Haarlem, Netherlands. It consists of two small slabs (specimens 6928 and 6929), part and counterpart, which contain impressions or parts of the left manus and forearm, pelvis, both legs and feet, and some gastralia. Faint impressions of wing feathers are also preserved (see Fig. 1). The Teyler Museum records indicate that it was collected sometime prior to 1857, and its discovery thus predates all the other currently known *Archaeopteryx* specimens. No precise locality or stratigraphic data are known at present, except that the slabs were found near Riedenburg, which is about 25 miles (40 km) east of Eichstätt and 32 miles (52 km) east of Pappenheim, the sites at which the Berlin and London specimens were found.

The specimen was described by von Meyer (*3*) in 1857 as the type of a new pterosaur species (*Pterodactylus crassipes*) and later was figured by him (*4*) in his monograph on the fossil reptiles of the Solnhofen lithographic limestone. The few elements preserved are distinct from all known pterosaurian remains in the extreme discrepancy of finger lengths and in the fact that digit 2 appears to have been nearly twice as long as metacarpal 2. Although probably referable to the same species as the London and Berlin specimens [although not all authorities accept de Beer's (*5*) judgment that those two specimens belong to a single species], the present remains are much too fragmentary for positive species identification.

The Teyler specimen is very fragmentary and far less spectacular than the London and Berlin specimens, factors that undoubtedly contributed to its misidentification. Some elements of the manus are, however, extremely well preserved and provide important new evidence that is not preserved in any of the other specimens. In addition to the terminal phalanges of digits 1 and 3, the actual horny claws are also preserved apparently uncrushed. Preservation of the horny claws is apparently unique among Mesozoic fossil vertebrate remains. The significance of the unusual form of these horny claws (see Fig. 2) cannot be fully assessed until careful comparisons are made with the Berlin specimen (planned for 1971). It is clear, however, that these structures provide important new evidence that must be considered in any future evaluation of the two principal theories on the origin of bird flight—arboreal versus cursorial. My own initial and very tentative interpretation is that these structures do not appear suitable for arboreal habits.

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References and Notes

1. H. von Meyer, *Neues Jahrb. Mineral. Geol. Palaeontol.* **1861**, 561 (1861).
2. ———, *ibid.*, p. 678.
3. ———, *ibid.* **1857**, 535 (1857).
4. ———, *Zur Fauna der Vorwelt: Reptilien aus dem lithographischen Schiefer des Jura in Deutschland und Frankreich* (Verlag von Heinrich Keller, Frankfurt-am-Main, 1860), plate 3.
5. G. de Beer, *Archaeopteryx lithographica* [British Museum (Natural History), London, 1954], pp. 1–68.

12 October 1970

Porifera: Sudden Sperm Release by Tropical Demospongiae

Abstract. *Three tropical marine demosponges inhabiting the deep coral reefs of Jamaica expel immense clouds of milky fluid from exhalant apertures. Analysis of samples shows this fluid to contain mature male gametes. The behavior is an individual or a population event in different species.*

Events of sexual reproduction in sponges have generally been inferred from histological studies of parental tissues (*1*). The presence and absence of gametes and larvae in successive samples indicate only the broad temporal boundaries of release of sexual products. The sudden release of huge clouds of spermatozoa from three species of tropical demosponges is reported here.

These three events occurred on the coral reefs bordering the north coast of Jamaica at Discovery Bay and were observed while scuba surveys of the reef fauna were being conducted. The dates and times of the observations were: *Verongia archeri* single individual, 3 p.m. 14 February 1969, 2 days before new moon; *Geodia* sp. single individual, 4 p.m. 2 July 1969, 3 days after full moon; *Neofibularia nolitangere* local population, 2:30 p.m. 23 October 1969, 2 days before full moon. There is only one previous report of a similar event (*2*).

A single specimen of *Verongia archeri* (Higgin) (Dictyoceratida), situated at a depth of 49 m on the deep fore-reef slope, emitted a column of "smoke" 3 m high for at least 10 minutes (Fig. 1). This was the only specimen of any species exhibiting this behavior in the surveyed area. Microscopic examination of the samples showed that the effluent contained immense numbers of mature spermatozoa (Fig. 2).

The second sponge, *Geodia* sp., belongs to an order (Choristida) in which evidence of sexual reproduction has rarely been reported (*3*). A single specimen, situated at 29 m on the upper edge of the deep fore-reef slope, released a diffuse turbid effluent for at least 20 minutes. Again, only this single individual was active in this process. Samples of the effluent again proved to contain mature spermatozoa (Fig. 3). Tissue samples of the sponge were taken the following day, fixed, desilicified in HF, and studied in section. Male gametes in ripe and developmental stages were still numerous throughout the deeper tissues.

The third sponge, *Neofibularia nolitangere* (Duch. and Mich.) (Poecilosclerida) (*4*), is a common species of the fore reef and fore-reef slope at depths from 10 to 30 m. Over an observation period of 30 minutes, approximately one-quarter of the surveyed colonies were emitting a diffuse cloud of material extending 2 to 3 m above the reef surface. Due to the toxic nature of the species, no attempt was made to collect

Fig. 1. Sperm release from a single 1.5-m-long *Verongia archeri* at 49 m.

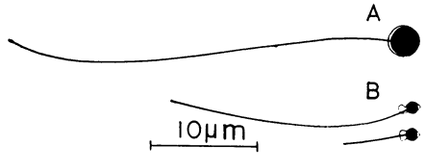

Fig. 2. Sponge sperm collected from effluent streams of (A) *Verongia archeri* and (B) *Geodia* sp. drawn to same scale.

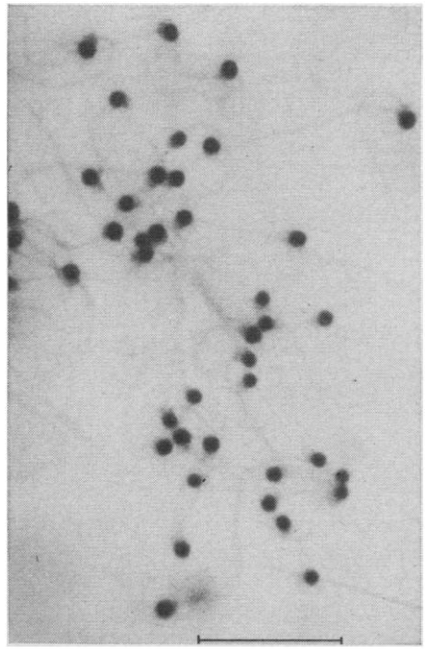

Fig. 3. Mature spermatozoa collected from effluent of *Geodia* sp. (scale, 10 μm).

samples. However, this was unquestionably another instance of sperm release. Within the area surveyed (100 by 100 m) the initiation of release spread from colony to colony down current. The activity spread at near-current velocities as sperm-laden water came into contact with successive colonies. By the end of the observational period all active colonies were still contributing to the 3-m-thick cloud which covered the entire observable reef.

The spermatozoa of *Verongia archeri* possess a head 2.6 μm in diameter which is almost completely filled by the uniformly dense-staining nucleus (Fig. 2A). This is followed by a tail 37 to 44 μm long without a recognizable midpiece intervening. The sperm of *Geodia* are slightly smaller but possess a more complicated structure (Fig. 2B). The head, 0.88 to 1.4 μm in diameter, is again almost entirely filled by the nucleus and is capped anteriorly by a short acrosomal cone. A midpiece sac of dimensions only slightly smaller is attached to the head at the junction of the 23- to 35-μm-long flagellum (*5*). No structural details are visible within the midpiece after normal staining with hematoxylin or toluidine blue.

Spectacular sudden release of huge numbers of spermatozoa seems to be normal for the Demospongiae since these observations concern species representing three orders of the two subclasses. The time of release may be related to new and full moon, but the data available are not sufficient to warrant statistical treatment. The presence of significant numbers of residual sperm in *Geodia* indicates that the sudden release of sperm is a repetitive event.

At the time of release of sperm by the *Neofibularia* population other sponges in the area were being observed over a long period for water pumping activity. The only species under constant observation, *Verongia* sp., underwent an abrupt decrease in activity to negligible values at this time. The depression continued for at least 2 days and slowly abated. The sudden release of huge numbers of gametes by large populations of sponges, as in the case of *Neofibularia* reported here and in the case of *Agelas* reported from Mexico (*2*), must constitute an environmental event of major significance to at least the other filter-feeding organisms of the reef and perhaps to the entire reef community.

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References and Notes

1. J. B. Gatenby, *J. Linn. Soc. London Zool.* **34**, 261 (1920a); *J. Roy. Microsc. Soc.* **40**, 277 (1920b); O. Tuzet, *Comp. Rend. Soc. Biol.* **103**, 970 (1930); *Comp. Rend. Hebd. Sci. Acad. Sci. Paris Ser. D* **191**, 1095 (1931); O. Duboscq and O. Tuzet, *Arch. Zool. Exp. Gen.* **81**, 395 (1942): P. R. Bergquist, M. E. Sinclair, J. J. Hogg, *Symp. Zool. Soc. London* **25**, 247 (1970).
2. B. Hollis, *Skin Diver* **17**, 36 (1968). A population of sponges on the reef of Cozumel, Yucatan, Mexico, released huge clouds of gray "smoke." The material was not identified. The published photographs strongly indicate that this was sperm released from the entire local population of *Agelas* sp. The time of the event was given no more precisely than late July, apparently 1968.
3. C. Lévi, *Syst. Zool.* **6**, 174 (1957); M. Sarà and N. Melone, *Ann. Pont. Ist. Sup. Sci. Lett. S. Chiara* **13**, 1 (1963); L. Liaci and M. Sciscioli, *Arch. Zool. Ital.* **52**, 169 (1967).
4. W. D. Hartman, *Postilla (Yale Peabody Mus.)* **113**, 1 (1967); P. R. Bergquist and W. D. Hartman, *Mar. Biol.* **3**, 247 (1969).
5. The released sperm described here are well within the great range of variability of sponge sperm described from tissue section materials [M. Leveaux, *Ann. Soc. Roy. Belg.* **73**, 33 (1942); O. Tuzet, *Arch. Zool. Exp. Gen.* **85**, 127 (1946); ——— and M. Pavans de Ceccatty, *Bull. Biol. Fr. Belg.* **92**, 331 (1958)]. The posterior projecting midpiece of *Geodia* sperm is somewhat similar to that reported only for the sponge *Halisarca dujardini* [C. Lévi, *Arch. Zool. Exp. Gen.* **93**, 1 (1956)].
6. The observations and laboratory work were carried out at the University of the West Indies and State University of New York Marine Laboratory at Discovery Bay, Jamaica. I thank the late Prof. T. F. Goreau and N. C. Copland for making the diving facilities and laboratory space available. I also thank Dr. W. D. Hartman for reviewing the manuscript, and R. A. Kinzie and E. A. Shinn for sperm collection and photography of the *Geodia* event. Supported by an NSF graduate student traineeship and a Sigma Xi grant in aid of research.

1 July 1970

Self-Inhibitor of Bean Rust Uredospores: Methyl 3,4-Dimethoxycinnamate

Abstract. *Two germination inhibitors from bean rust uredospores were identified as the* cis *and* trans *isomers of methyl 3,4-dimethoxycinnamate. They appear to be the "self-inhibitors" previously described from these spores.*

Uredospores of the rust fungi contain compounds which prevent germination unless removed, usually by flotation on water (*1*). These factors called "self-inhibitors" by earlier investigators were never identified (*2*). In a detailed study of the self-inhibitor from bean rust uredospores, Bell and Daly (*3*) showed that the inhibitor was extractable with water and appeared in two zones on