Arnold, John M., William C. Summers, Daniel L. Gilbert, Richard S. Manalis, Nigel W. Daw, and Raymond J. Lasek (1974) *A Guide to Laboratory Use of the Squid Loligo Pealei.* Woods Hole, MA: Marine Biological Laboratory, 74pp.

1. Natural History of the Squid

INTRODUCTION

Cephalopods in general and squid in particular have been the subject of considerable curiosity everywhere that man has become acquainted with the sea. These fast-moving animals possess a number of features usually associated only with vertebrate forms and to practitioners of anthropomorphism they appear to have considerable cunning. Popular accounts of these animals are recurrent and only a few will be mentioned to introduce the subject: Lane (1957) provided a comprehensive and readable coverage of cephalopods in a book slanted toward *Octopus;* Morton's (1958) introduction to mollusks sets the cephalopods among other members of the phylum; some invertebrate zoology tests, especially one by Russell-Hunter (1968), give good coverage of cephalopods; excellent photographic coverage can be found in articles by Voss and Sisson (1967 and 1971); and behavioral aspects of cephalopods are summarized in a concise book by Wells (1962).

Systematic position

Cephalopods are relatively large, active, predaceous mollusks with a high level of nervous development. There are approximately 400 living species which are distributed throughout all marine environments. Fossils of shelled cephalopods are well known and abundant in the Paleozoic and Mesozoic; their direct descendants are almost entirely extinct today, having been replaced by shell-less cephalopods which did not leave a fossil record. Modern forms are subdivided into the Nautiloidea (including only the relict genus *Nautilus*) and the Coleoidea, encompassing the remaining dibranchiate species. The latter are composed of eight-armed forms (Octopoda) and ten-armed forms (Decapoda) which include the true squids (Teuthoidea) and cuttlefishes (Sepioidea). Cuttlefishes possess a calcareous "cuttlebone", live in coastal water and do not populate the New World. The true squids can readily be separated into two groupings based on morphology and life habits; the Oegopsida, which are principally oceanic squids, and the Myopsida, which are coastal and mostly live over continental shelves. These names reflect diagnostic characters based on eye structure; the Oegopsida lack a transparent cornea over the eye which is present in the Myopsida. Speaking very generally, the Oegopsida are far ranging and not well known (see Clarke, 1966); the Myopsida tend to be restricted to definite coastal areas and, being more available, are better known through various life stages.

The English word "squid" is a dialectal variant of the word "squirt", which can readily be associated with locomotor activities of the live animal. The plural of "squid" is either "squid" or "squids"; the former, in the language of fishermen, is preferably restricted to several individuals of the same species. Thus, "squids" can appropriately be used in the sense of any number of individuals of more than one species. Most European languages share another root word which translate to the English "squid" (German: Kalmare; French: calmar; Italian: calamari; Spanish: calamar). Aristotle used the name "Teuthos" for *Loligo vulgaris* (Naef, 1923), from which we derive "Teuthoidea" and "Teuthology".

Among the physiologically useful squid of South America, *Dosidicus gigas* is known as "jibia" in Chile and "pota" in Peru. Species common to the coast of Venezuela are known locally as "luria" or "luria totora" in Cumana and "chipiron" or "chopo" in Caracas.

The genus *Loligo* was established in modern systematics by Lamarck in 1798. The name had been in earlier use (Schneider, 1784; Linnaeus, 1758), and is thought to have been used by Pliny (see Jaeckel, 1958; Naef, 1923). In the early nineteenth century this generic name was often used in a more general sense as a grouping for all true squids. In its current more restricted sense, the genus *Loligo* is one of the most widely distributed and representative of Myopsid squids.

Name

The French artist and naturalist, Charles Alexander Lesueur, described the species *Loligo pealeii,* along with several other new species of "cuttlefish" in 1821. Lesueur was a Curator of the Academy of Natural Sciences of Philadelphia from 1817 to 1825. There he became a close friend of Thomas Say for whom he illustrated and whom he later followed to New Harmony, Indiana. Lesueur lived in this utopian community for eleven years before returning to France. The description of *Loligo pealeii* appears to be based on one lot of preserved squid (perhaps one specimen) in the "Philadelphia Museum", whose origin is stated with doubt as the coast of South Carolina. The species is named for a Mr. R. Peale, the manager of that museum. The dedication most likely refers to Rubens Peale, son of Charles Peale (a famous American artist). A half brother, Titian Ramsey Peale was apprenticed to Rubens Peale in 1818 and continued in an association with the museum as curator and manager at various occasions until it was sold in 1849; however it seems unlikely that the dedication refers to Titian R. Peale.

By modern convention under the Rules of Zoological Nomenclature, a single "i" is preferred as the suffix in the formation of a scientific name. Hence, the corrected species name, *Loligo pealei,* is more acceptable in current usage. One commonly seen variation, *Loligo pealii,* represents a corruption of Peale's name and maintains the less preferred double "i" suffix. Verrill (1882) traces this latter spelling to Blainville in 1823, two years after the original description; its use continues especially among physiologists.

Among New England fishermen, *L. pealei* is sometimes called the "bone squid" to identify it separately from a common Oegopsid squid, *Illex illecebrosus,* which is known as the "summer squid". These same fishermen speak of "eyes" in their nets which are the strangled remains of small *L. pealei* caught in great numbers by the acute angles of the netting meshes.

Japanese fishermen designate *L. pealei* by the term "yari-ika", which translates literally to "spear squid", with possible reference to the spear-point shape of its fins.

Distribution

L. pealei is abundant between Cape Cod and Cape Hatteras along the East Coast of the United States (Summers, 1967, 1969). It has sometimes been referred to as the "common squid" over that range (Verrill, 1882), and has been reported from New Brunswick, Canada (Stevenson, 1934) to Colombia (LaRoe, 1967). Its appearance in the Minas Basin, Bay of Fundy (Mercer, 1970) was confirmed by egg masses and one newly hatched specimen captured during the summer of 1970 (Dr. and Mrs. Kay W. Peterson, personal communication). A. N. Vovk has reported

in personal communication that *L. pealei* has been taken by Russian trawlers on Browns Bank, south of Nova Scotia. I am not aware of any reports of this species occurring along the Nova Scotian peninsula nor farther to the north. The abundance of *L. pealei* is reported to fall off dramatically along the southern-Atlantic Bight and only scattered individuals occur in the Gulf of Mexico and the Caribbean Sea (LaRoe, 1967, and personal communication, Mercer, 1970).

Squids of the family Loliginidae are typically restricted to continental shelves and coastal margins and do not migrate over deep water. Voss (1967) lists them as inhabitants of the epipelagic zone in depths no greater than 200-400 m. I am unaware of any *L. pealei* being taken at depths greater than 200 fathoms (366 m.).

The sustained swimming speed of squid has not been determined with accuracy. The instantaneous speed of large *Loligo vulgaris* has been estimated at four knots (Packard, 1969). This is equivalent to the estimated emerging speed of leaping *L. pealei* and the much larger Humbolt Current squid, *Dosidicus gigas* (Cole and Gilbert, 1970). A number of observations have been made on the swimming speed of *L. pealei* in long aquarim tanks (Summers and McMahon, 1974). In these observations, large male squid (30-35 cm dorsal mantle length) easily maintained a speed of three knots in repeated runs over a 40-foot course. Smaller squid swam at slower speeds, but all of the animals tested attained a mantle cycling rate of just under one per second at maximum effort. The onshore migration of *L. pealei* must be at a rate of 100 nautical miles in one month as a minimum (Summers, 1969) or an average speed of one-seventh knot.

A marked seasonal migration occurs north of Cape Hatteras (Summers, 1969 and 1971). In general *L. pealei* is distributed over the continental shelf and especially abundant near shore during the warmer part of the year. In the winter, they are concentrated just below the continental shelf break in areas where the bottom water temperature is 8° C or higher. The northernmost range limit in the winter time is located along the southern edge of Georges Bank several hundred kilometers south of the Bay of Fundy. A few (transient?) individuals have been reported from the southern Nova Scotian shelf in November (Mercer, 1970). Thus, both onshore and along shore migrations must take place twice yearly. The onshore season lasts from late April to late November near Woods Hole and is thought to last longer farther south and be shorter north of Cape Cod. Size grouping usually remains unmixed at all times of the year and migrations proceed in the inverse order of size. There is no convincing evidence for sexual segregation in any of the sampled populations.

Abundance

Historically, there has been little cause to assess the abundance of *L. pealei.* The species was prominent in parts of its range and of modest commercial value. Landings of squid in the United States are often taken incidentally to the pursuit of more valuable fish species, and over the period 1879 to 1967, the domestic catch of *L. pealei* did not exceed one or two thousand metric tons a year (Lyles, 1968). Availability of the winter stock of *L. pealei* north of Cape Hatteras, based on otter trawl sampling, was tentatively placed at one billion and 50 million individuals using arithmetic and geometric mean catches respectively (Summers, 1967 and 1969). These data can be converted to an availability of approximately 40,000 and 2,000 metric tons of *L. pealei,* representing an undetermined portion of the total stock (Summers, 1969). A. N. Vovk (1969) summarized some recent Russian fishing experiences with the prospect of developing a fishery for the species. He stated that

the annual catch of *L. pealei* by Russian vessels amounted to 500 to 600 metric tons per year over the period 1958 to 1968. Vovk does not give a stock estimate but does report a conservative availability in a single thirty square mile area (near Wilmington Canyon in the month of March) of approximately 6 to 7 metric tons and tabulates expected catches of one to two metric tons per hour trawling in several areas.

In the winter of 1969-1970 the Japanese fishing fleet began large scale exploitation of *L. pealei* with a reported catch of 13,000 metric tons from the New York Bight (Bureau of Commercial Fisheries, market news release). In the winters of 1970-1971 and 1971-1972 Japanese fleets of 14-15 vessels returned to the same area for squid with reports of catches amounting to 8,000 and 16,000 metric tons, respectively. Effects of this fishery were not observed on inshore stocks near Woods Hole later in the years 1970-1971. Catch data on the 1972-1973 season are not complete (as of January 1974), but appear to be even greater than the above. The International Commission for North Atlantic Fisheries (ICNAF) has adopted a recommendation for sustainable yield of 50-80,000 metric tons per year for the statistical subareas ranging from George Bank to Cape Hatteras and a quota regulation of 71,000 metric tons for the 1974 calendar year. These figures apply to all species of squid, though *L. pealei* normally makes up most of the catch. Spain, Russia, Italy, and Poland also participate in the mid-Atlantic fishery for squid.