IOSR Journal of Pharmacy and Biological Sciences (IOSR-JPBS)
e-ISSN:2278-3008, p-ISSN:2319-7676. Volume 12, Issue 5 Ver. IV (Sep. – Oct. 2017), PP 51-60
www.iosrjournals.org

Is Sepiella inermis 'Spineless'?

Visweswaran B[1*]
[1]*Department of Zoology, K.M. Centre for PG Studies (Autonomous), Lawspet Campus, Pondicherry University, Puducherry-605 008, India.*
[*]*Corresponding Author: Visweswaran B*

Abstract: *Many a report seemed to project at a noble notion of having identified some novel and bioactive compounds claimed to have been found from Sepiella inermis; but lagged to log their novelty scarcely defined due to certain technical blunders they seem to have coldly committed in such valuable pieces of aboriginal research works, reported to have sophistically been accomplished but unnoticed with considerable lack of significant finesse. They have dealt with finer biochemicals already been reported to have been available from S.inermis; yet, to one's dismay, have failed to maintain certain conventional means meant for original research. This quality review discusses about the illogical math rooting toward and logical aftermath branching from especially certain spectral reports.*

Keywords: *Sepiella inermis, ink, melanin, DOPA*

Date of Submission: 16-09-2017 Date of acceptance: 28-09-2017

I. Introduction

Sepiella inermis is a demersally [1] bentho-nektonic [2], Molluscan, cephalopod 'spineless' cuttlefish species, with invaluable juveniles [3], from the megametrical Indian coast [4-6], as incidental catches in shore seine [7 & 8], as egg clusters [9] from shallow waters [1] after monsoon at Vizhinjam coast [10] and Goa coast [11] of India and sundried, abundantly but rarely [8].

II. Discussion

Habit and Habitat

The Genus of *S.inermis* was enlisted in national catalogues [12 & 13] from Malaysia [14], Japan [15], India [16] and England [17]. Critical [18] habitat of *S.inermis* provided wild eggs with lower survival [19 & 20]. *S.inermis* bore to the eastern and the western waters of the Indian Ocean [21], almost southern to Asia [22] probably from clockwise Coriolis Effect in the southern hemisphere but counter-clockwise in the northern hemisphere.

Sexual Dimorphism

The shells of *S.inermis* displayed clear sexual dimorphism [23-25] evident from trawling [26] which destructed benthic habitats [18]. Benthic habitats are critical for the crucial survival of *S.inermis*, amid trawling. Whole individuals of *S.inermis* were also incidentally collected from trawl-, push- and lift-nets [8, 22, 27 & 28] at Mandapam [29 & 30], India. Categories of its maturity stages [30] along with the genders as immature, maturing and mature are possible with its critical habitat [18] only, anabolizing females larger than males [22].

Incidental Availability

The incidentality of *S.inermis* might be due to the migratory behaviour of its females for the deposition of eggs [8], trawling [18] and exploitation [10]. Eastern catches of *S.inermis* in India find Palk Bay and Gulf of Mannar [31 & 32] as its inshore habitats from Coriolis Effect of two counter-clockwise water currents, thanks to Adam's bridge. *S.inermis*, once an edible inshore catch in India [33], distributed in Indian Ocean [34], might be exhausted by human exploitation. The counter-clockwise distribution of benthic *S.inermis* and other cephalopods was wide along the Indo-Pacific region [18, 35 & 36], comprising of Indian and Pacific inshores but tropically populated only by *S.inermis*, climatically oriented within the Tropics of Cancer and Capricorn. Such a phantom species was availed for its maternal migration into shores for breeding [8] and differences in the distribution of its habitats [18]. Maternal migration and hemispherical distribution of *S.inermis* signify for its specific complexity [22] amidst sparser availability [37].

Gender and Seasonality

Sexual dimorphism in *S.inermis* evinced from their shells [25], body length [8] and body weight [8] yet femininely mystified in spectral studies [38 & 39]. Length at sex-specific maturity varied across coasts of India [22] but spectrally missed [38 & 39].

Seasons varied in meat content of *S.inermis* [40 & 41] and in the water quality of the catch area of *S.inermis* [28]. The four seasons are dependants upon the inclination of the Earth, varying between the Tropics of Cancer and Capricorn, alternating along the hemispheres, revolutionally, reflecting in estuarine inputting into inshores as mineral variations in the meat of *S.inermis* [40 & 41]. Seasons play a role in the significant variations critiqued [18] in the habitat [42] as well as the meat of *S.inermis* [43].

Nutrition and Migration

Prawn was discovered the main food [30] digested by *S.inermis* [44]; mysid shrimps were constantly preyed upon by its hatchlings [45-48]. *Eurobowmaniella simulans* was found a trophically omnivorous but cannibalistic link between phytoplanktons and the juveniles of *S.inermis* [10], whose breeders were fed upon by *Nemipterus japonicus* [49], *Saurida tumbil* [50] and, passively, *Rachycentron canadum* [51]. *E.simulans, S.inermis* and *N.japonicus* were recorded together [52-54], *S.tumbil* trashed along with *S.inermis* at Tuticorin [55], India.

Salinity higher in the inshore waters of *S.inermis* collected during March along with slight alkalinity near river mouth [28] varying along the gradients of freshwater mixing with the marine water might ensure the sustainability of *S.inermis*, abundantly frequenting inshores during night [53]. Migration by some shallow-water cuttlefish species [56], including *S.inermis* [1 & 56], as a seasonal response to changes in temperature had also been reported [56]. Increase in the salinity of waters of the critical habitat of *S.inermis* [18] might have instigated its females and *E.simulans* to migrate nightly [10] and constrain their distribution [56] ashore.

Extinction of a prey species, say *E.simulans* [10], might initiate successive extinction of a predatory species, say *S.inermis*, followed by *N.japonicus* [49], *S.tumbil* [50] and *R.canadum* [51].

Maternity & Paternity

Spawning by *S.inermis* [8], when salinity increases in the coastal waters [28] after heavy rainfall [18] avoids trashing [55] by humans [18] and its males transfer sperm packets into the buccal area of females employing hectocotylized arms [56]. Free sperm were found penetrating into oocytes within the ovaries of some cephalopod species [57]. Females of *S.inermis* wipe spermatophores onto each egg [58-60] and mask their individual eggs laid with black pigments [61] from their ink-sac secretions for disguise [56] from marauders.

Juveniles

No sooner had they hatched than the hatchlings of *S.inermis* did show some adult behaviour [47]. Fully formed embryos of *S.inermis* had responded to experimental shocks, by giving gremlin jerks and releasing ink [20], staying within the transparent eggs. The release of ink in *S.inermis* might play an intraspecific-pheromonal role [62], ideal to its embryonic ink ejection. Ink ejection was an escape response of juvenile cephalopods [63] and the ink secreted by younger individuals of *S.inermis* contained higher concentrations of an alkaloid [63], melanin, which might anaesthetize the chemoreceptive senses of fish [63] predatory to *S.inermis* [63]. The juveniles of *S.inermis* involve dihydroxy phenyl alanine (DOPA) and dihydroxy phenethyl amine (DOPAmine) [62] to badly withstand extinction, staying planktonic in culture before becoming benthic [22] and grouping during immaturity [65] before they mature and later become mature spawners [30] in critical habitat [18] schooling with other cuttlefish species [60].

Melanin and Adaptation

Melanin biosynthesis in the ink gland of cephalopods under the catalysis of tyrosine by tyrosinase [66] possesses a metabolism broader than the production of melanin, initial after the maturation of the ink gland [67]. Tyrosinase critically limits the biosynthetic rate of melanin [68], an organic polymer of 5, 6-dihydroxyindole [69], not spectrally reported in the ink extracts from *S.inermis* [38 & 39].

Cuttlefish ink might be composed of melanin, enzymes and precursors of melanin [62]. DOPA and its derivatives upto melanin (polymer of 5, 6-dihydroxyindole) were all biosynthesized from tyrosine [67] but through different biosynthetic pathways, preferentially pulsated by the selective physiology of the animal, may it be *S.inermis*. Maturity of ink glands may be speculated in the juveniles and the spawning females of *S.inermis*, as they eject ink as a response to mechanical shocks [20] and as a disguise over eggs laid [56], respectively. The need of the animal, being DOPAminergic inhibition [70] of ink ejection, might have initiated the biosynthesis of DOPAmine in juveniles and spawners of *S.inermis*. The need, being melanin synthesis at maturity [67], in fully formed embryos [20], juveniles [63] and spawners [56] of *S.inermis*, might have cascaded the DOPAmine synthesized from tyrosine toward the melanin biosynthetic pathway [67].

DOPA and DOPAmine were reported to mimic the effects of cuttlefish ink on neurons [62] and DOPAmine is capable of inhibiting even milk ejection [70], which might be compared with ink ejection in *S.inermis*. The momentary adaptivity of tyrosinase strikes either the doping or the melanizing effects of DOPAmine to pocket the feeding and threatening behaviours, respectively, of *S.inermis*. Rapidity of oxidation of DOPA and DOPAmine in seawater after ink ejection by *S.inermis*, might be slowed down by an antioxidant

in the ink [62], failure of whose activity would result in weak control over ink ejection even in embryonic *S.inermis* [20].

Antioxidance

The spineless cuttlefish was known for containing selenium along with considerable number of microgrammes of antioxidant vitamin E [71], essential for impeding the oxidative degradation of polyunsaturated fatty acids (PUFAs), which process had also been clued for slowing down the oxidation of DOPA and DOPAmine by an antioxidant component in cuttlefish ink [62]. Concentrations of iron, manganese, zinc and copper had been estimated in *S.inermis* [72 & 73], which metals were cofactorially essential for physiologies of certain antioxidant enzymes [74]. Vitamin C was also an essential component of *S.inermis* along with vitamin A [71] both unsynthesizable by human anabolism, yet vitamin C essential for human absorption of dietary iron, which would also be inhospitable for the enzymatic antioxidation of certain oxidants [74] and, considerably, measured in *S.inermis* [72] also.

Ethics

More ethical fathom is required into the significance of maternal gender of *S.inermis* because they seem to be the incidental trawl-catches from their wild habitat [8], negligence of which would enter the species into the threatened category of IUCN [18]. Also, the feminine gender of *S.inermis* demands consideration, as its species name has suited its unarmed [74] but adaptive nature. Ethics [76] is of worse need in experiments involving and going to involve the wild species of *S.inermis*. Chloroform had been employed for extracting ink from *S.inermis* [38] but it must not be used as an extraction solvent [77 & 78].

De Novo

The cuttlefish ink clouds might alert the conspecifics as well as threaten the common predators [62]. Self-defending compounds could be synthesized by the organism from its diet or *de novo* [79]. Likewise, the juveniles of *S.inermis*, might have biosynthesized the components of its ink, from DOPA to melanin [67], *de novo*, speculated to be defensive from their predators, *N.japonicus* [49] and *S.tumbil*. *E.simulans*, with two species synonyms [80], was transferred from the genus *Gastrosaccus* to the genus *Eurobowmaniella* [81], owing to the complications it showed in its male copulatory organs [82]. The novel bioactive components believed to exist in the ink of *S.inermis* might have been metabolized from its 'complicated' prey, *E.simulans* and such a predatory species-specificity promises for a discovery of novel biocompounds from the extracts of *E.simulans, S.inermis, N.japonicus, S.tumbil* or *R.canadum* that seems to be phago-mimic [79], when released in the ink of *S.inermis*. Oxidation of phenols to quinines [62] catalyzed by tyrosinase [67] might prove a source for the chemicals hypothesized in cuttlefish ink [62].

Cultivability

S.inermis had successfully been cultured through generations [81] and proven a suitable species for successful mariculture in captivity [47, 48 & 84]. They attained first maturity at gender-specific sizes [22], mated and spawned after 80 days producing more than 200 viable eggs, incubating for less than 20 days [83 & 85] and hatching after 10 days [10] but dying after 100 days [22] under captivity [20]. Sexual reproduction in *S.inermis* might shuffle multihybrid alleles for a novel variety of bioactive compounds and, miscellaneously, useful to collagen industries [86 & 87].

Extraction

Aqueous Extraction

Aqueous ink extract [88] of juvenile *S.inermis* collected along the south-east coast of India [63] had been shown to have inhibited the catalysis by Moloney murine leukemia virus reverse transcriptase (MMLVRT) even at microconcentrations [63 & 79]. Extraction of bioactive products from *S.inermis* without employing any extraction solvent [88] seems to be effective, as even microconcentrations of those products had resulted to be inhibitory against the catalysis of a viral enzyme, MMLVRT [63].

Methanol Extraction and Survival

Methanol extract of hepatopancreas of *S.inermis* was reported an important source of bioactive compounds against certain fungi but not certain bacteria [89], which bactericidal principles might be either, lost or deconformed by methanol extraction [89]. Bacteria survive in estuarine waters [88] yet in the autochthonous ink cloud of *S.inermis* to be determined. Interestingly, a bacterium had been endeavoured as a probiotic in oral rehydration therapy (ORT) for cholera [91], whose biotics is to be combined with the aqueously extracted hepatopancreatic biotics of *S.inermis* in developing a remedy for cholera.

Multiple biases associated with the guanine-cytosine (GC) content [92] of a fungus (<50%) [93] might allow less probability for mutations in its genome, when compared to the antifungal properties of the methanol extract of sepiellar hepatopancreas. The GC content of another fungus was found still lower (<40%) [94], whose survival rate would be more [95] than that of the former, when encountered with the antifungal efficacies of the methanol extract of hepatopancreas of *S.inermis*, whose mitogenomic adenine-thymine (AT) content was reported as being about 75% [96 & 97].

The entire structure of spermatophore of *S.inermis* is non-cellular, except for the sperm [98], which fact is hypothesized that its spermatozoan must have been manchetted to the most, scarcely, with a single mitochondrion. The reported percentage of AT content of *S.inermis* mitogenome [96 & 97] is speculated for its exclusively maternal inheritance, availing mutations to survive all the critically adaptable habitats [18]. Fertilization very shortly before spawning in certain cephalopods [57] and the female cuttlefish wiping spermatophores onto each egg very immediate before spawning [56] might let *S.inermis* adapt toward an improbable incorporation of mitochondria into its male gametes.

Methanolic Preference

Methanol extracts of body tissues of *S.inermis* collected from south-east coast of India expressed good antibacterial activity against human pathogens *in vitro* [99 & 100], whereas aqueous ink extracts of juvenile *S.inermis* collected from the same locale directly inhibited the catalysis of a retroviral enzyme, MMLVRT [63]. The method of extraction plays an important role in preserving the intact conformations of bioactive components of *S.inermis*, comparatively inferred between the antibacterial efficacies of methanol extracts of, probably, its adult body tissues and the antiviral capability of aqueous extracts of its juvenile ink glands. Reconsideration is forwarded to methanolic extraction of bioactive compounds from *S.inermis*, for probably missing 5, 6-dihydroxyindole, monomer of melanin, from being spectrally reported [38 & 39]. Methanol, hazardous to humans, must be researched before being used for extraction of anything from *S.inermis*, as some study claim about developing drugs [39] from methanol ink extracts of *S.inermis* [38 & 39].

Chloroform Extraction

Chloroform is recommended not as an extraction solvent for phosgene formation [101]. Ink was extracted from *S.inermis*, using chloroform (200 ml) [38], which might have deconformed the integrity of the bioactive compounds by forming phosgene, capable of forming carbamate artifacts with amines [101] like DOPAmine in the ink of *S.inermis* [62 & 67] and eventually might have interferred the melanin synthesis. Amine is, unfortunately, available with tyrosine itself, to be probably carbamated by the phosgene formable from chloroform. Addition of methanol [38] might remove any phosgene formed but could not prevent artifact formation [101]. Hence, formation of carbamates with DOPAmine present in *S.inermis* ink could not be avoided [101], which might have resulted as the spectral absence of the 5, 6-dihydroxyindole in spectral study [38] involving chloroform with the ink of *S.inermis*.

Shell Extraction

The ethylene diamine tetra acetate (EDTA) extract of oligosaccharides from the internal shell of *S.inermis* also showed antibacterial activity [100] almost in a similar pattern exhibited by the whole body tissue extract of *S.inermis* [99 & 100]. This has brought out the agency of the constituent oligosaccharides of the spineless cuttlefish in having exhibited certain antibiotic activities.

Butanol Extraction

Butanol extract of ripe accessory nidamental gland of *S.inermis* had shown some antibacterial activity [79 & 102]. In this case also, the reported bactericidal property of accessory nidamental gland extract from *S.inermis* might also have had been after being treated with butanol, which could not be tolerated even by the same bacterial species, naturally catalysing its production, above certain level of concentration [103].

Cuttlebone Extract

The cuttlebone of *S.inermis* had shown some antimicrobial activity [104] while the methanol extract from its flesh showed some cytotoxicity [105]. Methanol extraction from its flesh might have been the cause for cytotoxicity, while its cuttlebone extract was found antimicrobial, probably because of its chitin [73] or chitosan [106], which was also reported from its shell [107].

Cuttlefish seemed to be good targets for cancer therapy [108] and the ink of *S.inermis* had inhibited the growth of certain organisms [109]. The chitin from the cuttlebone of *S.inermis* had also been substrated for the activity of chitinase isolated from a bacterial species [73].

Plagiarism

Plagiarism is weeding into cuttlefish research [39 & 110]. It seems hardly practical to access an exclusively terrestrial ecosystem with large catchers like fishing vessels [38, 39 & 111]. *S.inermis* could have easily been identified from its common name itself, as spineless cuttlefish or needle cuttlefish [76 & 113] but not [38 & 39]. The very idea of a dark ink with its melanin granules suspended in a viscous colourless medium originally stated not for the ink of *S.inermis* but for the waste of *Sepia officinalis* [114] seemed to have been mistaken along many a publication [38, 39 & 115 - 119] because of very little care.

Ethnomedicine

Cuttlefish ink is a Chinese traditional medicine listed in the Compendium of Materia Medica [120] listed down in Chinese classic Shen Nong Ben Cao Jing [121]. Such an ink available from *S.inermis* would prove a suitable remedy with its constituent bioactive components, if properly investigated and interpreted, employing a finer extraction method.

Citation

The release by *S.inermis* as ink was declared a defense to the animal [39] and so the animal 'armed' but the species name of the animal tends to mean "unarmed" [75]. The claim [38 & 39] for the ink of *S.inermis* as if being produced for its defense [122] had not been so. The original research work [122] had been performed not with *S.inermis*, a cuttlefish, but a squid, *Sepioteuthis sepioidea* yet improperly cited with meddlesome paraphrasing [38] and spineless plagiarism [39].

Significance

Proper sharing of organized knowledge [123] is demanded by any field of research to flourish, as research is faithfully based on previous reports; but the quality of the information especially accumulated through spectral reports about *S.inermis* [38 & 39] duplicately phishing with little statistical significance [38 & 39]. Statistical significance is required to discuss more significant results toward a scientific conclusion [74 & 124].

III. Conclusion

If properly extracted with methods involving harmless solvents and significantly reported with required finesse, *S.inermis* would grow to be one of the best research organisms.

Acknowledgement

Author acknowledges the immense help received from the scholars whose articles are cited and included in references of this manuscript. The author is also grateful to authors / editors / publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

References

[1]. Sundaram S, Khan MZ. Stock assessment of Sepiella inermis (Orbigny, 1848) from Mumbai waters. Journal of the Marine Biological Association of India. 2009;51(2):178-83.
[2]. Nabhitabhata J. Sepiella inermis. In Cephalopod Culture 2014 (pp. 225-240). Springer Netherlands.
[3]. Ramkumar, S., et al. "Evaluation of Economic Impact on Juvenile Landings of Cephalopods in Mumbai Waters, Northwest Coast of India." Current World Environment 10.3 (2015): 1004-1010.
[4]. Winckworth, E. Marine Mollusca from South India and Ceylon. J Molluscan Stud 1936; 22 (1): 16-23.
[5]. Sanilkumar, V., et al. "Coastal processes along the Indian coastline." Indian Academy of Sciences, 2006.
[6]. Salim, Shyam S., et al. "Climate change and need for proactive marine fisheries sector." (2017).
[7]. Rao KV. Molluscan fisheries. (1958)
[8]. Jones, S. "The molluscan fishery resources of India." (1969): 906-918.
[9]. Silas.E.G.,Sarvesan.R.,Nair.K.P.,AppannaSasthri.Y.,Sreenivasan.P.V.,Meiyyappan.M.M.,KuberVidyasagar., Satyanarayana Rao K., and Narayana Rao B (1985), Some aspects of the biology of cuttlefishes, CMFRI Bulletin 37, June 1985, 49-70.
[10]. Neethu Raj, P., M. K. Anil, and Rohini Krishna. "Seasonal availability and population structure of Eurobowmaniella simulans W. Tattersall, 1915 (Crustacea: Mysida) along Vizhinjam coast, Kerala, India." Journal of the Marine Biological Association of India 58.1 (2016): 13-20.
[11]. Velip, Dinesh T., and Chandrashekher U. Rivonker. "Regional Studies in Marine Science." (2015).
[12]. Paetel F. Catalog der Conchylien-Sammlung: nebst Uebersicht des angewandten Systems. Paetel; 1873.
[13]. Berry SS. A catalogue of Japanese Cephalopoda. Proceedings of the Academy of Natural Sciences of Philadelphia. 1912 Jan 1:380-444.
[14]. Joubin L. Céphalopodes d'Amboine. 1894.

[15]. Pilsbry HA, Stearns F. Catalogue of the Marine Mollusks of Japan: With Descriptions of New Species and Notes on Others Collected by Frederick Stearns. Frederick Stearns; 1895.
[16]. Goodrich ES. I. Report on a Collection of Cephalopoda from the Calcutta Museum. Transactions of the Linnean Society of London. 2nd Series: Zoology. 1896 Dec 1;7(1):1-24.
[17]. Linnean Society of London. Transactions of the Linnean Society of London: Zoology. The Society; 1900.
[18]. Abubakr, Mohammed M. "October 2004." (2004).
[19]. Anil, M. K. "Egg collection and larval rearing of cephalopods-Winter School on Recent Advances in Breeding and Larviculture of Marine Finfish and Shellfish." (2009).
[20]. Anil, M. K. "Captive behaviour of cephalopods." (2013).
[21]. Barratt, I. & Allcock, L. 2012. Sepiella inermis. The IUCN Red List of Threatened Species 2012: e.T162500A903191. http://dx.doi.org/10.2305/IUCN.UK.2012-1.RLTS.T162500A903191.en. Downloaded on **22 August 2017**.
[22]. Reid, A., Jereb, P. & Roper, C.F.E. 2005. Family Sepiidae. In Jereb P, Roper CF, editors. Cephalopods of the world: chambered nautiluses and sepioids (Nautilidae, Sepiidae, Sepiolidae, Sepiadariidae, Idiosepiidae, and Spirulidae). Food & Agriculture Org.; 2005 FAO Species Catalogue for Fishery Purposes. No. 4, Vol. 1. Rome, FAO. pp. 57-152.
[23]. APPELLOF , A., 1893. Die Schalen von Sepia, Spirula und Nautilus. Svensk. Vet. Ak. Handl., vol. 25 no. 7, pp. 1-106.
[24]. ADAM W. CONSIDERATIONS SUR LA SYSTEMATIQUE DES SEPIIDAE (CEPHALOPODA). Feestbundel bij de opening van het Kolveniershof en het Rubenianum. 1936:263.
[25]. Adam W. CONSIDERATIONS SUR LA SYSTEMATIQUE DES SEPIIDAE (CEPHALOPODA). (1964)
[26]. Sayana, K. A., Remesan, M. P., Madhu, V. R., Pravin, P., & Edwin, L. (2016). Appraisal of Trawl Designs Operated Along Kerala Coast.
[27]. Sasikumar, G., K.S. Mohamed and D. Nagaraja 2009. Comparison of biological characteristics of FADassisted and unassisted fishing methods. In: Marine Ecosystems Challenges and Opportunities, Book of Abstracts (Ed. E. Vivekanandan et al), Marine Biological Association of India, February 9-12, 2009, Cochin, p 64-65.
[28]. Baran, E., et al. "2 Aquatic Resources and Environmental." Tropical deltas and coastal zones: food production, communities and environment at the land-water interface 9 (2010): 13.
[29]. James PS, Soundararajan R. On a sperm whale Physeter macrocephalus Linnaeus stranded at Krusadai Island in the Gulf of Mannar, with an up-to-date list and diagnostic features of whales stranded along the Indian coast. Journal of the Marine Biological Association of India. 1979; 21 (1 & 2): 17-40.
[30]. Unnithan KA. Observations on the biology of cuttlefish Sepiella inermis at Mandapam. Indian Journal of Fisheries. 1982; 29 (1&2): 101-11.
[31]. Sundaram KS, Sarvesan R, Mohamed KH, Shanbhogue SL. Catalogue of Molluscs, Prawns, Stomatopods and Marine Algae in the Reference Collections of the Central Marine Fisheries Research Institute. CMFRI Bulletin. 1969;9:1-52.
[32]. Venkataraman, K., et al. "Studies on faunal diversity and Coral Reef Ecosystems of Palk Bay, India." Rec. zool. Surv. India, Occ. Paper No 279.1 (2007): 47.
[33]. Rao, K. Virabhadra. "Distribution pattern of the major exploited marine fishery resources of India." (1973): 18-101.
[34]. Adam W. Cephalopoda from the Red sea. Bulletin. Sea Fisheries Research Station (Haifa). 1973.
[35]. Roper, C. F. E., M. J. Sweeney and C. E. Nauen. 1984. FAO species catalogue, Vol. 3, Cephalopods of the world. An annotated and illustrated catalogue of species of interest to fisheries. FAO. Fish.
[36]. Roeleveld MA, Lipiński MR, Augustyn CJ, Stewart BA. The distribution and abundance of cephalopods on the continental slope of the eastern south Atlantic. South African Journal of Marine Science. 1992 Jun 1;12(1):739-52.
[37]. Monolisha, S., and J. K. Edward. "Biodiversity of marine mollusc from selected locations of Andhra Pradesh coast, South eastern India." (2015).
[38]. Ravichandiran M, Thiripurasalini S, Ravitchandirane V, Gopalane S, Stella C. Chemical constituents and anti-tuberculosis activity of ink extracts of cuttlefish, Sepiella inermis. Journal of Coastal Life Medicine. 2013;1(4):253-7.
[39]. VASANTHARAJA, Dasal, Vaithilingam RAVITCHANDIRANE, and Veerappan ANANDAN. "Anti-Microbial Activity and Spectro-Chemical Investigation of Ink Extracts of." Notulae Scientia Biologicae 6.3 (2014): 273.
[40]. Suryanarayanan, H., R. Shylaja Kumari, and K. M. Alexander. "Biochemical investigations on the edible molluscs of Kerala 2. A study on the nutritional value of some gastropods and cephalopods." Fishery Technology 10.2 (1973): 100-104.

[41]. Sarvaiya, R. T. "Studies on mollusca of Saurashtra coast-3. Composition." Fishery Technology 14.2 (1977): 170-175.
[42]. Sreekanth GB, Manju Lekshmi N, Chakraborty SK, Jaiswar AK, Zacharia PU, Vishnuradhan R, Singh NP, George D, Pazhayamadom G. Effect of monsoon on coastal fish diversity of Goa: an example from the gillnet fishery. Indian Journal of Fisheries. 2016; 63(2):8-18.
[43]. Das, Manotosh, Joydev Maity, and Basanti Samanta. "Marine molluscan fauna found at Digha coast, West Bengal, India." (2016).
[44]. Varghese, Oommen P., and P. Dinamani. The digestive system in the cephalopode. Diss. Cochin University of Science and Technology, 1975.
[45]. Choe S., 1966. On the eggs, rearing, habits of fry and growth of some cephalopods. Bull. Mar. Sci., 16(2):330-348.
[46]. Nabhitabhata J., 1994. The culture of cephalopods. Fishing Chimes, September:12- 16.
[47]. Sivalingam D., 1999. Successful breeding and hatchery experiments of the spineless cuttlefish Sepiella inermis at Tuticorin shellfish hatchery. Mar. Fish. Infor. Serv. T&E Ser., No.161: 11 – 13.
[48]. Anil MK. Laboratory rearing and breeding of spineless cuttlefish Sepiella inermis Orbigny (Mollusca: Cephalopoda). Journal of aquaculture in the tropics. 2003.
[49]. Manojkumar, P. P., P. P. Pavithran, and N. P. Ramachandran. "Food and feeding habits of Nemipterus japonicus (Bloch) from Malabar coast, Kerala." Indian Journal of Fisheries 62.1 (2015): 64-69.
[50]. Manojkumar, P. P., and P. P. Pavithran. "Diet and feeding habits of Saurida tumbil (Bloch, 1795) from northern Kerala, south-west coast of India." Indian Journal of Fisheries 63.4 (2016): 41-47.
[51]. Sajeevan, M. K., and B. Madhusoodana Kurup. "Stomach content analysis of Cobia Rachycentron canadum (Linnaeus, 1766) from North West coast of in India." (2016).
[52]. Tan, H. S., B. A. R. Azman, and B. H. R. Othman. "Taxonomic status of mysid shrimps (Crustacea) from Peninsular Malaysia waters." Malayan Nature Journal 66.3&4 (2014): 103-116.
[53]. Azila, A., and V. C. Chong. "Multispecies impingement in a tropical power plant, Straits of Malacca." Marine environmental research 70.1 (2010): 13-25.
[54]. Thomas, Sujitha, A. P. Dineshbabu, K. M. Rajesh, Prathibha Rohit, G. D. Nataraja, and P. Mishal. "Environmental influence on the secondary productivity and fish abundance in coastal fishing grounds off Mangalore, south-eastern Arabian Sea." Indian Journal of Fisheries 61, no. 3 (2016): 24-32.
[55]. Jeyasanta, K., and Jamila Patterson. "Survey on landing of trash fishes in the major fish landing centers of Tuticorin, South east coast of India." (2017).
[56]. Sasikumar, Geetha, A. P. Dineshbabu, K. M. Rajesh, Bindu Sulochanan, P. S. Swathi Lekshmi, Sujitha Thomas, and Prathibha Rohit. "Impact of Aggregating Devices on Cuttlefish fishery." (2013).
[57]. Silas, E. G. "Cephalopoda of the west coast of India collected during the cruises of the research vessel Varuna, with a catalogue of the species known from the Indian Ocean." (1968): 277-359.
[58]. Perez JA, Haimovici M, Cousin JC. SOUTH AMERICAN ELEDONIDS (CEPHALOPODA OCTOPODA). Malacologia. 1990; 32(1):147-54.
[59]. Sasikumar, Geetha. "Cuttlefish biology." (2013).
[60]. Sasikumar, G., et al. "Policy Guidance on cuttlefish fishery using Fish Aggregating Devices. CMFRI Mar. Fish. Policy Ser. 1, 56p. ISSN: 2394-8019 2015 Central Marine Fisheries Research Institute All right reserved. Material contained in this publication may not be reproduced in any form without the permission of the publisher Printed at: St." (2015).
[61]. Neethu, R. P., Anil, M. K. & Rohini Krishna, M. V. (2015). Studies on egg morphology, availability and hatching of four species of cephalopods along Vizhinjam Coast, Kerala. International Journal of Innovative Research and Development 4, 209–214.
[62]. Lucero, Mary T., Heraldo Farrington, and William F. Gilly. "Quantification of L-dopa and dopamine in squid ink: implications for chemoreception." The Biological Bulletin 187.1 (1994): 55-63.
[63]. Rajaganapathi, J., S. P. Thyagarajan, and J. K. Edward. "Study on cephalopod's ink for anti-retroviral activity." (2000).
[64]. Ruppert EE & Barnes RD, Invertebrate Zoology, 6th edition (Saunders College Publishing, London) 1994, 481. In: Rajaganapathi, J., S. P. Thyagarajan, and J. K. Edward. "Study on cephalopod's ink for anti-retroviral activity." (2000).
[65]. Yasumuro, Haruhiko, Shogo Nakatsuru, and Yuzuru Ikeda. "Cuttlefish can school in the field." Marine Biology 162.4 (2015): 763-771.
[66]. Winder, Alison J., and Henry Harris. "New assays for the tyrosine hydroxylase and dopa oxidase activities of tyrosinase." The FEBS Journal198.2 (1991): 317-326.
[67]. Fiore, Gabriella, P. O. L. I. Annarita, Anna Di Cosmo, Marco d'ISCHIA, and Anna Palumbo. "Dopamine in the ink defence system of Sepia officinalis: biosynthesis, vesicular compartmentation in mature ink

gland cells, nitric oxide (NO)/cGMP-induced depletion and fate in secreted ink." Biochemical Journal 378, no. 3 (2004): 785-791.
[68]. Lee, Ho Yeon, Eun Jeong Jang, Song Yi Bae, Ju-eun Jeon, Hyen Joo Park, Jongheon Shin, and Sang Kook Lee. "Anti-melanogenic activity of gagunin D, a highly oxygenated diterpenoid from the marine sponge Phorbas sp., via modulating tyrosinase expression and degradation." Marine drugs 14, no. 11 (2016): 212.
[69]. Dinneen, Sean R., et al. "Color Richness in Cephalopod Chromatophores Originating from High Refractive Index Biomolecules." The Journal of Physical Chemistry Letters 8 (2017): 313-317.
[70]. Paturi B, Ryan RM, Michienzi KA, Lakshminrusimha S. Galactorrhea with metoclopramide use in the neonatal unit. Journal of Perinatology. 2009 May 1;29(5).
[71]. Chakraborty, Kajal, Minju Joy, and P. Vijayagopal. "Nutritional qualities of common edible cephalopods at the Arabian Sea." International Food Research Journal 23.5 (2016): 1926-1938.
[72]. Dious SRJ, Kasinathan R (1992) Concentrations of Fe Mn Zn and Cu in Cephalopod Sepiella inermis (Mollusc: Decapoda). Indian J Geo-Mar Sci 21:224-225.
[73]. Revathi, M. , Saravanan, R. and Shanmugam, A. (2012) Production and characterization of chitinase from Vibrio species, a head waste of shrimp Metapenaeus dobsonii (Miers, 1878) and chitin of Sepiella inermis Orbigny, 1848. Advances in Bioscience and Biotechnology, **3**, 392-397.
[74]. Visweswaran, B., and G. Krishnamoorthy. "Oxidative stress by tartrazine in the testis of Wistar rats." Journal of Pharmacy and Biological Sciences 2.3 (2012): 44-49.
[75]. Shimomura M, Ohtsuka S, Tomikawa K. Ingolfiella inermis n. sp., a new interstitial ingolfiellid amphipod from Okinawa, southern Japan (Peracarida, Amphipoda). Crustaceana. 2006 Oct 1;79(9):1097-105.
[76]. Moltschaniwskyj, Natalie A., et al. "Ethical and welfare considerations when using cephalopods as experimental animals." Reviews in Fish Biology and Fisheries 17.2-3 (2007): 455-476.
[77]. Roe FJ, Palmer AK, Worden AN, Van Abbé NJ (1979) Safety evaluation of toothpaste containing chloroform. I. Long-term studies in mice. Journal of Environmental Pathology and Toxicology. 2(3): 799–819.
[78]. WHO (2004) EVALUATION OF CERTAIN FOOD ADDITIVES AND CONTAMINANTS Sixty-first report of the Joint FAO/WHO Expert Committee on Food Additives WHO TechnicalReportSeries — 922: 11-18.
[79]. Nair, J. Rajasekharan, Pillai D, Joseph SM, Gomathi P, Senan PV, Sherief PM. Cephalopod research and bioactive substances (2011).
[80]. Sawamoto, Shozo. "CURRENT STATUS OF MYSID TAXONOMY IN SOUTHEAST ASIA." Marine Research in Indonesia 39.1 (2015): 1-14.
[81]. Murano M. 1996. Note on withdrawal of Eurobowmaniella phuketensis and transference of Gastrosaccus simulans Tattersall to its genus. (Crustacea – Mysidacea). Phuket Marine Biological Center Research Bulletin 61: 65-66.
[82]. Abraham, Biju, and Saramma U. Panampunnayil. "Mysids (Crustacea) from the shallow waters off Maharashtra and south Gujarat, India, with description of a new species." Marine Biology Research 5.4 (2009): 345-362.
[83]. Nabhitabhata J. Life cycle of three cultured generations of spineless cuttlefish, Sepiella inermis (Férussac and D'Orbigny, 1848). Phuket Marine Biological Center Special Publication. 1997;17(1):289-98.
[84]. Anil, M. K., Joseph Andrews, and C. Unnikrishnan. "Growth, behavior, and mating of pharaoh cuttlefish (Sepia pharaonis Ehrenberg) in captivity." (2005).
[85]. Deepak Samuel.V and Jamila Patterson (2015) Studies on the embryonic development of pharaoh's cuttlefish Sepia pharaonis Ehrenberg, 1831 under laboratory conditions Indian Journal of Geo-Marine Sciences Vol. 44(4), April 2015, pp. 609-13.
[86]. Shanmugam, V.; Ramasamy, P.; Subhapradha, N.; Sudharsan, S.; Seedevi, P.; Moovendhan, M.; Krishnamoorthy, J.; Shanmugam, A.; Srinivasan, A. Extraction, structural and physical characterization of type I collagen from the outer skin of Sepiella inermis (orbigny, 1848). Afr. J. Biotechnol. 2012, 11, 14326–14337.
[87]. Muthumari K, Anand M, Maruthupandy M. Collagen Extract from Marine Finfish Scales as a Potential Mosquito Larvicide. The Protein Journal. 2016 Dec 1;35(6):391-400.
[88]. Takaya, Y., Uchisawa H., Matsue H., Okuzaki B., Narumi F., Sasaki J., et al., 1994. An investigation of the antitumor peptidoglycan fraction from squid ink. Biol. Pharm. Bull.17: 846-849.
[89]. Rajaganapathi, J., K. Rajagopal, and J. K. Edward. "Antifungal and cytotoxic effects of methanol extracts of three marine molluscs." (2001).
[90]. Hood MA, Ness GE. Survival of Vibrio cholerae and Escherichia coli in estuarine waters and sediments. Applied and Environmental Microbiology. 1982 Mar 1; 43(3):578-84.

[91]. Sengupta C, Ekka M, Arora S, Dhaware PD, Chowdhury R, Raychaudhuri S. Cross feeding of glucose metabolism byproducts of Escherichia coli human gut isolates and probiotic strains affect survival of Vibrio cholerae. Gut Pathogens. 2017 Jan 17; 9(1):3.
[92]. Romiguier J, Roux C. Analytical Biases Associated with GC-Content in Molecular Evolution. Frontiers in Genetics. 2017 Feb 15; 8:16.
[93]. Yin G, Zhang Y, Pennerman KK, Wu G, Hua SS, Yu J, Jurick WM, Guo A, Bennett JW. Characterization of Blue Mold Penicillium Species Isolated from Stored Fruits Using Multiple Highly Conserved Loci. Journal of Fungi. 2017 Mar 1; 3(1):12.
[94]. Storck, Roger. "Nucleotide composition of nucleic acids of fungi II. Deoxyribonucleic acids." Journal of bacteriology 91.1 (1966): 227-230.
[95]. Saikumari D, Saxena N. Isolation and Identification of Extra-aquatic, Pathogenic Fungi from the Polluted Water of Munneru River, Telangana, India. Int. J. Curr. Microbiol. App. Sci. 2017; 6(1):71-7.
[96]. Cheng R, Zheng X, Ma Y, Li Q. The complete mitochondrial genomes of two octopods Cistopus chinensis and Cistopus taiwanicus: Revealing the phylogenetic position of the genus Cistopus within the Order Octopoda. PloS one. 2013 Dec 17; 8(12):e84216.
[97]. Wang W, Guo B, Li J, Wang H, Qi P, Lv Z, Wu C. Complete mitochondrial genome of the spineless cuttlefish Sepiella inermis (Sepioidea, Sepiidae). Mitochondrial DNA. 2015 Jan 2;26(1):151-2.
[98]. Guerra Á, Pedrosa GP. Las pesquerías mundiales de cefalópodos: situación actual y perspectivas. Consejo Superior de Investigaciones Científicas; 1983.
[99]. Ramasamy, Pasiyappazham, et al. "In vitro evaluation of antimicrobial activity of methanolic extract from selected species of cephalopods on clinical isolates." African Journal of Microbiology Research 5.23 (2011): 3884-3889.
[100]. Vairamani, S., et al. "Antibacterial activity of methanolic extract of whole body tissue and ethylene diamine tetra acetate extract of cuttlebone of sepiella inermis (orbigny, 1848)." Research Journal of Microbiology 7.5 (2012): 263.

[101]. Maudens KE, Wille SM, Lambert WE. Traces of phosgene in chloroform: Consequences for extraction of anthracyclines. Journal of Chromatography B. 2007 Apr 1; 848(2):384-90.
[102]. Sherief, P. M., et al. "Antibacterial activity in the extract of accessory nidamental glands of squid and cuttlefish." Saiyed Asif Husain Abidi, National Institute of Ocean Technology (Madras, India), Society of Biosciences (India). Proceedings of the National Seminar on New Frontiers in Marine Bioscience Research. 2004.
[103]. Liu S, Qureshi N. How microbes tolerate ethanol and butanol. New biotechnology. 2009 Oct 31; 26(3):117-21.
[104]. Ilamparithi, C., Anto Shering, M., Brito Raj, S., and Kavimani, S. A study about antioxidant and anticancer activity of methanolic extract of squid, Sepia brevimana and Sepiella inermis, 2011; 2: Issue 2. In: Diaz, Jemma Hermelin Jesy, and R. D. Thilaga. "GC-MS ANALYSIS OF METHANOLIC EXTRACT FROM THE INTERNAL SHELL OF CEPHALOPODS." (2015).
[105]. Ilamparithi C, Anto Shering M, Brito Raj S and Kavimani S: A study about antioxidant and anticancer activity of methanolic extract of squid, Sepia brevimana and Sepiella inermis, International Journal of Pharma World Research. 2011; 2(2): 1-10. In: Diaz, Jemma Hermelin Jesy, R. D. Thilaga, and V. Sivakumar. "IN-VITRO CYTOTOXIC ACTIVITY OF SQUID AND CUTTLEFISH BONE EXTRACT ON HEP G2 CELL LINE." International Journal of Pharmaceutical Sciences and Research 6.2 (2015): 778.
[106]. Khakshoor, Mohammad Sadegh, and Jamileh Pazooki. "Volume: 4: Issue-5: May-2015 ISSN: 2278-0246 Coden: IJAPBS www. ijapbs. com SCREENING OF ANTIMICROBIAL POTENTIAL OF CHITOSAN AND POLYSACCHARIDE EXTRACTED FROM CUTTLEBONE OF SEPIA PHARAONIS (EHRENBERG, 1831)."
[107]. Vairamani, S., Subhapradha, N., Ramasamy, P., Raveendran, S., Srinivasan, A., and Shanmugam, A. (2013). Physicochemical characteristics and antioxidant efficacy of chitosan from the internal shell of spineless cuttlefish Sepiella inermis. Prep. Biochem. Biotechnol., 43, 696-716.
[108]. Diaz, Jemma Hermelin Jesy, and R. D. Thilaga. "GC-MS ANALYSIS OF METHANOLIC EXTRACT FROM THE INTERNAL SHELL OF CEPHALOPODS." (2015).
[109]. Diaz, Jemma Hermelin Jesy, and R. D. Thilaga. "SCREENING OF ANTIMICROBIAL ACTIVITIES IN THE INK OF CEPHALOPODS AGAINST HUMAN PATHOGENS." drugs 1.2 (2016): 3-4.
[110]. Bhimba, Valentin, Vakaathi Vinod, and Cindhu Beulah. "Marine sponge sigmadocia pumila a potential supply for drug findings." Journal of Pharmacy Research 6.4 (2013): 401-403.
[111]. Sumathi VR, Natesan U, Sarkar C. GIS-based approach for optimized siting of municipal solid waste landfill. Waste management. 2008 Nov 30; 28(11):2146-60.

[112]. Jones S. Fisheries of the west coast of India. (1958)
[113]. Nabhitabhata J, Kakhai N, Suriyawarakul J, Nilaphat P. Feeding and cost of seed production of cephalopods, Sepioteuthis lessoniana Lesson; Sepia pharaonis Ehrenberg; Sepiella inermis Fer. & di'Orb. Technical Paper. 1996(1).
[114]. Souissi, Nabil, et al. "Preparation and use of media for protease-producing bacterial strains based on by-products from Cuttlefish (Sepia officinalis) and wastewaters from marine-products processing factories." Microbiological research 163.4 (2008): 473-480.
[115]. Neifar, A., et al. "Physicochemical characterization of Sepia officinalis ink and the effects of storage conditions on the coagulation process." Journal of the Marine Biological Association of the United Kingdom 89.4 (2009): 803-807.
[116]. Balti, Rafik, et al. "Influence of degree of hydrolysis on functional properties and angiotensin I-converting enzyme-inhibitory activity of protein hydrolysates from cuttlefish (Sepia officinalis) by-products." Journal of the Science of Food and Agriculture 90.12 (2010): 2006-2014.
[117]. Liu, Huazhong, et al. "Effects of squid ink on growth performance, antioxidant functions and immunity in growing broiler chickens." Asian-Australasian Journal of Animal Sciences 24.12 (2011): 1752-1756.
[118]. Neifar, Aref, et al. "Investigations on tyrosinase activity in melanin-free ink from Sepia officinalis: potential for food proteins cross-linking." European Food Research and Technology 235.4 (2012): 611-618.
[119]. Ktari, Naourez, et al. "Effect of degree of hydrolysis and protease type on the antioxidant activity of protein hydrolysates from cuttlefish (Sepia officinalis) by-products." Journal of Aquatic Food Product Technology 22.5 (2013): 436-448.
[120]. Zhong, Jie-Ping, et al. "Protective effects of squid ink extract towards hemopoietic injuries induced by cyclophosphamine." Marine drugs 7.1 (2009): 9-18.
[121]. Zhu, You-Ping. Chinese materia medica: chemistry, pharmacology and applications. CRC Press, 1998.
[122]. Wood JB, Maynard AE, Lawlor AG, Sawyer EK, Simmons DM, Pennoyer KE, Derby CD. Caribbean reef squid, Sepioteuthis sepioidea, use ink as a defense against predatory French grunts, Haemulon flavolineatum. Journal of experimental marine biology and ecology. 2010 May 31; 388(1):20-7.
[123]. Senguttuvan, Banupriya. Knowledge sharing model for IT small and medium enterprises: the case of Indian companies. Diss. Kaunas University of Technology.
[124]. Ramalingam, V., G. Krishnamoorthy, and P. Govindarajulu. "Enzymes of carbohydrate metabolism in human breast carcinoma: relationship with serum hormones." Neoplasma 41 (1994): 49-49.

IOSR Journal of Pharmacy and Biological Sciences (IOSR-JPBS) is UGC approved Journal with Sl. No. 5012, Journal no. 49063.

Visweswaran B. "Is Sepiella inermis 'Spineless'?" IOSR Journal of Pharmacy and Biological Sciences (IOSR-JPBS) , vol. 12, no. 5, 2017, pp. 51–60.