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FOOD HABITS AND STOMACH CONTENTS OF EUROPEAN SEA BASS (*Dicentrarchus labrax*) FROM BARDAWIL LAGOON, NORTH SINAI, EGYPT

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ABSTRACT

The European sea bass (*Dicentrarchus labrax*) is an apex predator in Bardawil Lagoon, with significant ecological and economic value in Egypt, especially for local fisheries. This study investigates the feeding habits and stomach contents of *D. labrax* in Bardawil Lagoon, North Sinai, Egypt, over one fishing season from June 2023 to January 2024. A total of 413 specimens were collected monthly from commercial catches to examine their dietary composition, seasonal variations, and feeding intensity. The stomach contents were analyzed using microscopic examination and standard dietary assessment techniques, The analysis revealed that the diet of D. labrax is diverse, consisting mainly of crustaceans and fish parts, followed by polychaetes, mollusks, seagrasses, and unidentified materials. Crustaceans (53%) and fish remains (28%) dominated the diet across all size groups, while the consumption of polychaetes (6%), mollusks (6%), and seagrasses (5%) decreased as the fish grew larger. Monthly variations in diet composition indicated that crustacean consumption peaked in October (60%), while fish parts were most consumed in September (35.5%). Feeding intensity varied throughout the year, with the highest proportion of full stomachs recorded in September (35.29%), suggesting increased feeding activity, whereas the lowest feeding intensity was observed in December, with 75.86% of the stomachs empty. A size-based dietary shift was also noted, where smaller fish relied more on crustaceans, while larger individuals preferred fish as a primary food source. The findings of this study provide insight into the trophic behavior of *D. labrax* in Bardawil Lagoon, which can aid in sustainable fishery management and aquaculture practices.

INTRODUCTION

Sea bass is an apex predator known for its opportunistic feeding habits, consuming the most abundant available food sources **(Boulineau-Coatanea, 1969; Kennedy and Fitzmaurice, 1972; Aranda *et al*., 1999).** Feeding behaviour and dietary preferences vary with the size of individuals. Younger specimens primarily feed on Mysidacea **(Moreira *et al*., 1992)**, while their diet also includes copepodites, amphipods, isopods, and, to a lesser extent, bivalves (Cerastoderma), decapods **[***Carcinus maenas* **(Linnaeus, 1758)]**, and small fish species (Atherina, Pomatoschistus, and Gobius) **(Costa, 1988; Mehanna *et al*., 2010)**. The composition of their diet can vary with tidal phases, showing an increase in amphipods and polychaetes during the ebb tide **(Cabral and Costa, 2001; Laffaille *et al*., 2001)**. According to **Rodríguez-García *et al*. (2024)**, 25 distinct prey items were identified, categorized into six groups: Annelids, Crustaceans, Insects,

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Molluscs, Osteichthyans, and Chelicerates. Among these, mysidaceans (Crustacea, Order *Mysida*) were the most dominant dietary component, accounting for 66.6% of the Index of Relative Importance (IRI).

The European Sea bass (*Dicentrarchus labrax* L., 1758) belongs to the Moronidae family and is distributed across the Mediterranean, Black Sea, and Eastern Atlantic coastlines, ranging from Great Britain to Senegal **(Mehanna, 2006)**. In 2012, the total production of *D. labrax* reached 134,978 tonnes, with Turkey, Greece, Spain, Italy, Egypt, and Croatia being the primary producers in the Mediterranean region **(FEAP, 2014)**. Additionally, the catch of *D. labrax* amounted to 5,569 tonnes in 2021 **(FAO, 2021)**. The sea bass production in Lake Bardawil varied between 26 and 90 tons from 2003 to 2015, before rising to approximately 124-134 tons during the 2016-2017 fishing season **(Shalloof *et al*., 2019)**.

D. labrax is a key marine species in Bardawil Lagoon and holds significant economic value in Egypt due to its export potential to Europe **(Abdel-Hakim *et al*., 2010)**. This species primarily inhabits coastal lagoons and estuaries but has occasionally been observed in rivers. It thrives in a wide range of water conditions, from highly saline to brackish, and exhibits oceanodromous behaviour. Thanks to its euryhaline (0–40 ppt salinity) and eurythermic (2–32°C) adaptability, it can be found in waters as shallow as 2–10 meters and as deep as over 100 meters **(Haffray *et al*., 2007)**. In natural habitats, *D. labrax* reproduce once a year, with the Mediterranean population breeding from December to March, while Atlantic populations extend their breeding season until June **(Muusand Nielsen, 1999).** In controlled environments, broodstock can adjust their breeding schedule through photoperiod manipulation, allowing reproduction up to three times a year during winter, spring, or autumn **(Kousoulaki *et al*., 2015).** The aim of this study was to analyse the diet of *D. labrax* and investigate feeding habits in relation to fish size, habitat, and month for both wild and farmed populations. This will facilitate future comparisons of populations within the same species.

MATERIAL AND METHODS

The stomach contents of 413 individuals were analyzed to learn more about the eating habits of *D. labrax*, a commercially captured species. These fish were caught with hooks at various sites across Bardawil Lagoon, with monthly sampling from June 2023 to January 2024, the samples were taken at night, which affected the results of the feeding intensity analysis, as the *D. labrax* is known to be a highly active nocturnal predator. This study examined the species' yearly food composition, seasonal dietary variations, diet changes relative to length, and feeding intensity. The entire length of each fish specimen was measured to 0.1 cm precision. Each fish was dissected, with the digestive tract meticulously removed by incisions at the stomach's entrance site into the abdominal cavity and just anterior to the anus. The amount of stomach fullness was visually assessed and classified as empty, half full, or fully full, using the methods described by **Pillay (1952)**. The stomach was carefully split open lengthwise, and the contents were scraped out and put in a tiny Petri plate with very little water. Using a binocular microscope, the food items were sorted and classified. A complete inventory of the general food items was then created. Food was analyzed using established assessment criteria **(Hynes, 1950; Hyslop, 1980),** and the findings were statistically evaluated using **Godfriaux's (1969)** methodology to gain more accurate insights into the dietary of *D. labrax* patterns and feeding behaviour.

RESULTS

Annual Food Items Monthly Variation in Food Items Food Items in Relation to Fish Size Annual Food Items

The stomach contents of the examined species indicated a varied spectrum of dietary components, as seen in Fig. 1. Crustaceans accounted for 53.0% the dietary of D. *labrax* diet, followed by fish parts (28.0%) and polychaetes worms (6.0%). Molluscs contributed around 6.0%, with seagrasses accounting for 5.0%. Unidentified materials that could not be characterized had the lowest concentration of 2.0%.

Monthly and Seasonal Variation in Food Items

Table 1 shows the monthly changes in food items. Food products were present all year long during the trial. Crustaceans and fish parts were the predominant dietary items at the research site (Bardawil Lagoon) between June 2023 and January 2024, as shown in Table 1 and Fig. 2.

The percentage of crustaceans reached its highest value in October, at 60.0% in Bardawil during 2023. Fish parts recorded their highest percentage in September, reaching 35.29% at the study site. Polychaete worms were present throughout the year and recorded their highest percentage in January 2024, reaching 12.0%. On the other hand, Molluscs and seaweed reached their highest levels of dietary items in January 2024, with percentages of 8.50% and 8.70%, respectively, where their percentages were consistently low throughout the year, with minor fluctuations. Unidentified materials were often discovered alongside food items and were consistently present throughout the year, reaching their highest recorded level in June at 5.60%.

Hangs in the diet are influenced by environmental factors, particularly the seasonal variations in the availability of different food sources within the lagoon. For example, during the summer (June to August), fish primarily consumed crustaceans, while their diet became more varied during the autumn season (September to December). The most notable dietary shift occurs in the autumn, with fish parts becoming a larger portion of the diet, particularly in September. This could reflect an increase in the abundance or accessibility of other fish species during this period. During the winter, crustaceans continued to be the main food source, while the proportion of fish in the diet decreased. The data hints that *D. labrax* adjusts its diet based on the seasonal availability of food sources, which could be influenced by factors like water temperature, prey abundance, and ecological interactions.

Food Items in Relation to Fish Size

Table 2 illustrates how the diet of *D. labrax* changes as the fish grow, showing a shift from a diet primarily based on crustaceans to one that increasingly relies on fish and larger prey. The data reveals a flexible feeding pattern shaped by the fish's growth stage and the availability of food resources in Bardawil Lagoon.

The *D. labrax* were classified into 10 size groups, ranging from 21 cm to 50 cm, with a 2 cm interval between each group. Prey size is related to the fish's size, with larger fish tending to consume larger prey, while smaller fish feed on smaller prey. As the fish grow, the consumption of fish parts and crustaceans increases, while the consumption of Molluscs, seaweed, and unidentified materials decreases.

Crustaceans are the main food source for smaller fish, making up 46.5% of the diet in the 21–23 cm size group. However, their contribution decreases as fish size increases, reaching 14.3% in the 39–41 cm size group. The importance of fish parts increases with fish size, representing 62.0% of the diet in the 39–41 cm group and 65.0% in the 47–45 cm group. The nutritional importance of polychaetes decreases with fish size, dropping from 14.7% in the smallest size group to 4.8% in the largest size group.

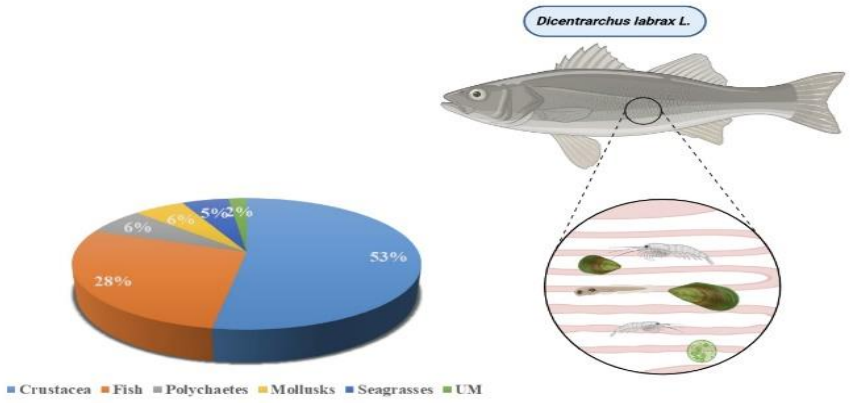

Fig. 1. The food items of *Dicentrarchus labrax* L. in Bardawil lagoon during 2023

Table 1. Monthly and seasonal variation in diet composition of *Dicentrarchus labrax* L. in Bardawil lagoon during 2023

Seasons	Month	No.	Crustacea	Part of fish	Polychaetes	Molluscs	Seagrasses	UM
Summer	**Jun 2023**	22	44.90	28.20	8.20	6.70	6.40	5.60
	July	17	43.10	30.40	5.70	7.30	8.20	5.30
	Aug	12	52.50	28.00	5.67	6.90	6.30	0.60
Autumn	**Sep**	22	52.5	35.50	3.50	3.60	4.34	0.60
	Oct	21	60.00	31.00	3.20	3.00	1.90	0.90
	Nov	24	58.72	28.41	3.84	3.40	3.60	2.00
Winter	**Dec**	23	58.8	23.00	10.30	5.50	1.80	0.60
	Jan 2024	19	50.5	19.73	12.00	8.50	8.70	0.50

UM = undermined materials consists of digested food and a portion of the bottom substrate.

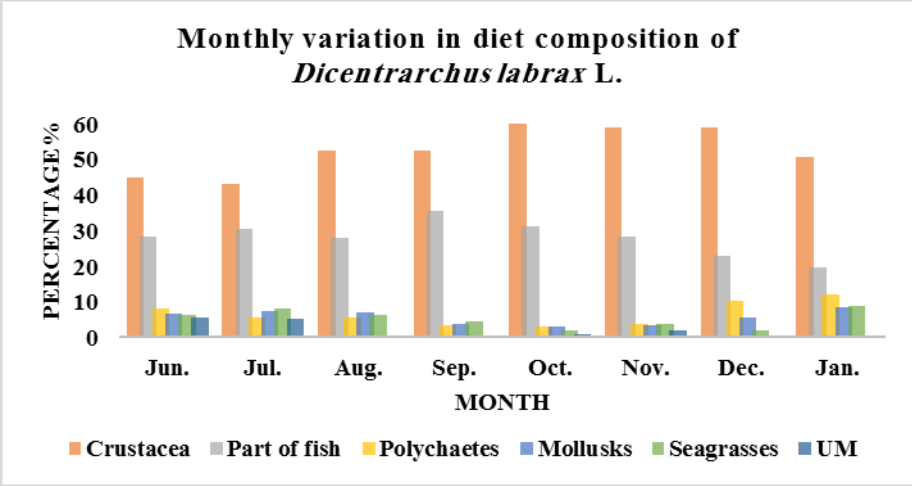

Fig. 2. Monthly variation in diet composition of *Dicentrarchus labrax L.* in Bardawil lagoon during 2023

Table 2. The percentage of diet composition (%) of different size classes of *Dicentrarchus labrax* L. at Bardawil lagoon during 2023

Size groups (cm)	No.	Crustacea	Part of fish	Polychaetes	Molluscs	Seagrasses	UM
21-23	18	46.5	27.8	14.7	7.7	2.3	1.0
24 -26	35	45.3	26.2	15.2	5.6	6.7	1.0
27-29	20	40.1	40.8	7.1	6.4	3.4	2.2
30- 32	15	34.9	42.2	9.5	6.5	7.0	0.0
33- 35	12	17.8	17.8	44.4	11.1	8.9	0.0
36- 38	16	29.3	60.5	2.0	4.1	0.0	4.1
39- 41	11	14.3	62.0	9.5	8.2	.00	6
42-44	10	26.7	50.0	6.7	10.0	6.7	0.0
45- 47	11	15.6	65.0	2.4	3.7	10.8	2.4
48- 50	12	26.1	52.2	4.8	13.0	2.2	1.7

UM = undermined materials consists of digested food and a portion of the bottom substrate.

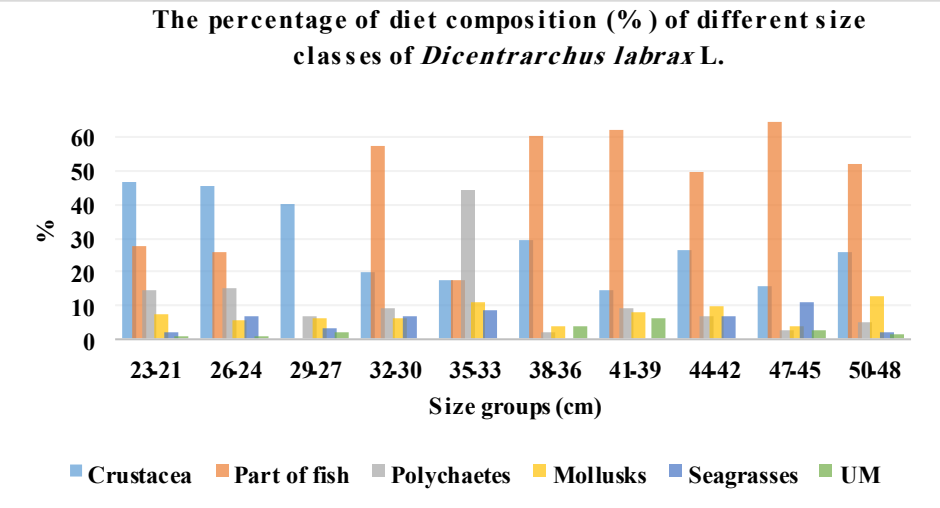

Fig. 3. Monthly variation in food items of *Dicentrarchus labrax* L. in Bardawil lagoon during 2023

Molluscs remain a consistent but secondary component in the diet, ranging from 3.7% to 13.0%, with the highest percentage observed in the largest size group (50–48 cm). Seagrasses play a secondary role in the diet, ranging from 0% to 10.8%. Interestingly, seagrasses are absent in the diets of fish in the 38–36 cm and 41–39 cm size groups. Unidentified materials are found in small amounts across most size groups, ranging from 0% to 10.8%, with no clear pattern linked to fish size.

Feeding Intensity

Stomach fullness was categorized into three levels: empty, half-full, and full. Overall, the largest proportion of full stomachs was seen in September (35.29%), indicating a peak in eating activity among the people investigated. The lowest percentages of full stomachs were recorded in October (8.82%) and November (8.97%), indicating a decrease in eating activity throughout these months. September had the highest proportion of half-full stomachs (47.06%), indicating increased eating activity. Fish with empty stomachs were most common in December (75.86%), indicating a considerable decrease in eating during this month.

An investigation of *D. labrax*'s monthly feeding intensity fluctuation found that eating activity was generally stable over the summer months (June-August), with full stomach percentages ranging from 10.53% (July) to 21.87% (June). However, empty stomachs were quite common during this period, especially in July (73.68%) and August (70.83%), indicating a decrease in eating intensity in midsummer. During the fall (September-November), September had the largest eating activity, as evidenced by higher percentages of full (35.29%) and half-full stomachs (47.06%). Feeding intensity decreased dramatically in October and November, with empty stomachs increasing to 58.82% and 67.94%, respectively.

The drop-in feeding activity lasted during the winter months (December-January). December had the largest number of empty stomachs (75.86%), while January showed a modest improvement in eating, with 24% full stomachs and 28% half-full stomachs, albeit empty stomachs still accounted for 48% of the observations.

DISCUSSION

The food and feeding habits of seabreams have been studied by many authors. The research addressed the dietary habits in the Mediterranean and France, as well as growth and nutrition in Portugal. **(Costa, 1988; Cabral and Costa, 2001; Laffaille *et al*., 2001; Khalil and Shaltout, 2006; Dufour *et al*., 2009; Abdel-Hakim *et al*., 2010; Rogdakis *et al*., 2010; Rodríguez-García *et al*., 2024).**

The diets of fish are influenced not only by their feeding behavior but also by their digestive morphology and mouth structure **(Stickney *et al*., 1974).** Additionally, feeding habits play a significant role in regulating or affecting the distribution, migration, and growth of fish **(Papaconstantinou and Caragitsou, 1992).**

D. labrax in Lake Bardawil to better understand its feeding behavior. Among the 413 samples analyzed from *D. labrax*, 162 (39.23%) contained food in their stomachs, while 251 samples (60.77%) were empty, likely due to fishing taking place at night. Where the European seabass is recognized as a highly active nocturnal predator **(Gibson *et al*., 1998).** This diurnal variation in behavior may be attributed to increased predatory activity at night, with the species focusing on capturing its main prey, such as small fish and mysidaceans, which are more abundant in the surf zone after dark. The increase in zooplankton during the night in the surf zone has been documented in several studies **(DeLancey, 1987; Lasiak and McLachlan, 1987)**. This surge in zooplankton availability is likely to attract other fish species to the surf zone for feeding **(Gaelzer *et al*., 2006)**, potentially enhancing the consumption of bony fish (osteichthyes) by both the European seabass and the spotted seabass.

The findings indicated that Dicentrarchus labrax is a carnivorous species, with an increase in the consumption of crustaceans and fish parts as the size of the fish grows, while the intake of polychaetes, Molluscs, and algae decreases with larger fish sizes. Crustaceans and fish were clearly identified

Table 3. Monthly variation in the intensity of feeding of *Dicentrarchus labrax* L. in Bardawil lagoon during 2023

Months	No.	State of stomachs					
		Full	%	Half	%	Empty	%
Jun	64	14	21.87	16	25	34	53.12
July	38	4	10.53	6	15.79	28	73.68
Aug	48	8	16.67	6	12.5	34	70.83
Sep	34	12	35.29	16	47.06	6	17.64
Oct	68	6	8.82	22	32.35	40	58.82
Nov	78	7	8.97	18	23.07	53	67.94
Dec	58	8	13.79	6	10.34	44	75.86
Jan	25	6	24	7	28	12	48

as the most significant prey for *D. labrax* (Fig. 1). In this study, it was observed that the proportion of crustaceans in the diet decreases as fish size increases, while the proportion of fish parts rises with larger fish sizes. Smaller individuals (less than 29 cm) mainly consume small crustaceans (such as shrimp parts, crab parts, and isopods) and small fish. In contrast, larger fish (over 29 cm) tend to prey on larger fish, large shrimp, isopods, and small crabs. As the body size of larvae increases, they become more efficient at capturing and consuming a greater number of prey. This enables them to adapt their behavior by increasing their swimming activity in response to higher prey densities, as noted by **(Georgalas *et al*. 2007).**

These findings align with the results of **(Khalil and Shaltout, 2006; Abdel-Hakim *et al*., 2010; Rodríguez-García *et al*., 2024),** who studied the feeding habits of *D. labrax* in Bardawil Lagoon, and in Southwest Iberian Peninsula They noted that feeding behavior is closely linked to fish size, with juveniles primarily consuming small crustaceans (including amphipods, mysids, and isopods) and small fish like Atherina and Gobiidae. For fish larger than 20 cm, shrimp and crabs become more prevalent prey. Similarly, **Bakhoum (1996)** found that the primary diet of *D. labrax* in Bardawil Lagoon consisted of crustaceans (amphipods, shrimp, mysids, isopods, and crabs), making up 48% of the diet, followed by bony fish (such as juvenile bass, eels, and gray mullet), which accounted for 36%. Additionally, the diet included polychaetes (5%), aquatic insects, some snails, algae, and aquatic plants.

Conclusion

The current study investigated the dietary habits of the European sea bass (*Dicentrarchus labrax*) in Bardawil Lagoon, North Sinai, Egypt. The findings indicated that crustaceans and fish parts were the dominant food sources, while the consumption of polychaetes, molluscs, and seagrasses declined as the fish matured. Monthly fluctuations in feeding activity were observed, with a notable peak in October. Additionally, dietary composition varied with fish size, as smaller individuals primarily consumed crustaceans, whereas larger ones shifted to a diet dominated by fish and larger prey items.

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الملخص العربي

عـــادات التغـذية ومحتويات المعدة لأسماك القاروص في بحيرة بردويـــل، شـمال ســيناء، مصـــــر

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١. قسم الثروة السمكية والأحياء المائية، كلية العلوم الزراعية البيئية، جامعة العريش، مصر.

٢. شعبة المصايد، المعهد القومي لعلوم البحار والمصايد، مصر.

القاروص الأوروبي (*Dicentrarchus labrax*) هو مفترس قمة في بحيرة بردويل، وله قيمة بيئية واقتصادية كبيرة في مصر، خاصة للصيد المحلي. تتناول هذه الدراسة تركيب النظام الغذائي لسمك القاروص الأوروبي على مدار موسم صيد واحد، من يونيو ٢٠٢٣ إلى يناير ٢٠٢٤. تعرض الدراسة النظام الغذائي لـ ٤١٣ عينة من سمك القاروص الأوروبي، تم جمعها من الصيد التجاري في مواقع إنزال مختلفة في بحيرة بردويل، شمال سيناء، مصر، شهريًا. كما أظهرت الدراسة تركيب النظام الغذائي السنوي، والتقلبات الشهرية، والتغيرات الغذائية على مر الزمن، وشدة التغذية تم تحليل محتويات المعدة باستخدام الفحص المجهري وتقنيات التقييم الغذائي القياسية. أظهرت التحليلات أن نظام الدنيس الأوروبي الغذائي متنوع، حيث يتكون أساسًا من القشريات وأجزاء الأسماك، الديدان الشوكية، الرخويات، الأعشاب البحرية، وجزء من تربة القاع غير معروف التصنيف. خلال شهور الدراسة وفى كل الأطوال، كانت القشريات وأجزاء الأسماك المصدرين الرئيسيين للغذاء لجميع الفئات الحجمية لسمك القاروص الأوروبي، في حين أن استهلاك الديدان الشوكية، الرخويات، والأعشاب البحرية انخفض مع نمو السمك. في أكتوبر، كانت نشاطات التغذية لسمك القاروص الأوروبي مرتفعة بشكل خاص.

الكلمات الاسترشادية: عناصر الغذاء، القاروص الأوروبي، منخفض البردويل.

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