



**Seed Morphology and Dispersal Features
of *Euphorbia hypericifolia* L. (Euphorbiaceae)
from a New Distributional Area in Benghazi, Libya**

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***Euphorbia hypericifolia* L. مورفولوجيا البذور وخصائص انتشار نبات
من أماكن توزيع جديدة في بنغازي، ليبيا**

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Abstract

This study documents a new distribution record for *Euphorbia hypericifolia* L. (Euphorbiaceae) in Benghazi, Libya. Plant specimens were collected from three different locations: Al-Fuwaiha, Jamal Abdel Nasser Street, and Bu Snieb. Morphometric analysis showed that the seeds, which are broadly elliptic to elliptic, have average dimensions of 0.715 mm in length and 0.496 mm in width. This results in an average length/width (L/W) ratio of 1.447. Their surface is slightly wrinkled or transversely furrowed, with shallow, irregular transverse ribs. The research confirms that the species uses Ballochory (explosive dispersal) through the three-lobed capsule (regma) as its main method for distribution. But it isn't the main reason for its effective spread across Eastern Libya. One-Way Analysis of Variance (ANOVA) found that the mean seed length and L/W Ratio were not statistically significant among the three locations, confirming the overall morphometric stability of the seed structure. However, the analysis showed a significant difference in the mean Capsule Length among the three sites ($F = 4.3164$, $P = 0.0232$). This data enhances our understanding of the species distribution, growth patterns and serves as an important basis for updating plant records in Libya.

Keywords: Seed Morphology, *Euphorbia hypericifolia* L., Distributional, Benghazi, Libya.

المخلص

توثق هذه الدراسة تسجيلاً جديداً لتوزيع نبات *Euphorbia hypericifolia* L. في بنغازي، ليبيا. جُمعت عينات نباتية من ثلاثة مواقع مختلفة وأظهر التحليل المورفومتري أن البذور يبلغ متوسط أبعادها 0.715 ملم طولاً و0.496 ملم عرضاً، مما ينتج عنه نسبة طول إلى عرض (L/W) متوسطة تبلغ 1.447. البذور سطحها مجعد قليلاً أو ذو أخاديد عرضية، مع أضلاع عرضية ضحلة وغير منتظمة. يؤكد البحث أن هذا النوع النباتي يستخدم الانتشار الانفجاري (Ballochory) عبر الكبسولة ثلاثية الفصوص كطريقة رئيسية للتوزيع. إلا أن هذه الطريقة ليست السبب الرئيسي لانتشاره الفعال في شرق ليبيا. وقد أظهر تحليل التباين أحادي الاتجاه أن متوسط طول البذرة ونسبة الطول إلى العرض لم يكونا ذا دلالة إحصائية بين

المواقع الثلاثة، ومع ذلك، أظهر التحليل فرقاً ذا دلالة إحصائية في متوسط طول الكبسولة بين المواقع الثلاثة. تُعزز هذه البيانات المفهوم العلمي لتوزيع هذا النوع وأنماط نموه، وتُشكل أساساً هاماً لتحديث سجلات النباتات في ليبيا.

الكلمات المفتاحية: مورفولوجيا البذور، *Euphorbia hypericifolia* L.، التوزيع الجغرافي، بنغازي، ليبيا.

Introduction

Libya, situated along the Mediterranean coast in North Africa and bordered by Egypt, Tunisia, Algeria, Chad, Niger, and Sudan, is the fourth largest country in Africa by land area, encompassing approximately 1,759,540 km². Its extensive land borders stretch about 4,348 km, while its Mediterranean coastline extends over 1,900 km, flanked by maritime territorial waters reaching approximately 22.2 kilometers [1]. Dominated by desert and semi-desert terrain, which makes up about 80 percent of its landscape, the country nevertheless contains dramatic topographical contrasts, from its highest point in the Tibesti Mountains (2,266 meters above sea level) to the lowest point at Sabkha Ghazil (47 meters below sea level). These regions are interspersed with scattered grasslands transitioning from the coast to central areas, with the vast southern expanses characterized by arid deserts, hills, and sand dunes [2].

Benghazi is located between (32°07'N 20°04'E) it's the second-largest city and primary urban center in Libya, situated on the northern coast of North Africa. It functions as a major harbor on the Gulf of Sidra in the Mediterranean Sea, and is the managerial and commercial area of the eastern Libyan region of Cyrenaica [3] (Figure.1).



Figure 1. A satellite googles earth map of Libya showing location of Benghazi.

Euphorbiaceae is one of the most species-rich families and *Euphorbia* L. has the fifth largest number of genera among species of angiosperm, which have been found to be highly diverse and challenging to classify. Particularly the most recent taxonomic censuses which include what were formerly the genera *Chamaesyce* and *Pedilanthus* as part of an expanded concept of *Euphorbia*, currently recognize about more than 2,100 to 2,250 accepted species [4].

Euphorbiaceae classified into three subfamilies, Acalyphoideae, Crotonoideae, and Euphorbioideae, which includes the widely distributed genus *Euphorbia*. There are roughly 37 tribes in total. New molecular phylogenetic studies [7], like the Angiosperm Phylogeny Group APG. IV. system, which divided earlier groups (like Phyllanthoideae) into separate families to guarantee the remaining taxa are monophyletic, are the basis for the current structure (Euphorbiaceae sensu stricto). The tribe Euphorbieae and its subtribe Euphorbiinae belong to the subfamily Euphorbioideae, which is distinguished by the highly reduced cyathium inflorescence. It is now widely believed that this subfamily only includes the large and intricate genus *Euphorbia* [8; 9].

In the Flora of Libya, Euphorbiaceae comprises a total of five genera and 32 species and the *Euphorbia* is represented by 27 species [5]. The recognized 27 species of the *Euphorbia* in Flora of Libya existing floristic literature has recently undergone an essential expansion. This flora has been significantly enriched by the discovery of two new species; *Euphorbia hirta* L., formally recorded from the Gabes region near Tobruk [6], and

Euphorbia hypericifolia L., also confirmed for the country in Tobruk [6]. These essential new additions, representing the first records for these taxa in the nation, collectively raise the existing number of identified *Euphorbia* species in the Libyan flora to 29 species.

This study discusses our findings that significantly enhance prior understanding. We detail the discovery and confirmation of *Euphorbia hypericifolia* L. at three new sites in the city of Benghazi in Libya. Also we set out to map and report on these new sites. To properly assess this species' invasive potential, we will supply empirical data. We look at the colonization patterns of the plant and its conservation status in the Mediterranean climate of Cyrenaica. This info is to serve as the base which we will build upon for updates to Libyan plant records and models of ecological trends.

Material and methods

1. Study Area and Description of locations

Plant specimens were collected from three distinct locations in Benghazi; Al-Fuwaihat (Pepsi Street), Jamal Abdel Nasser Street, and Bu Snieb. The geographical coordinates for each location are detailed in (Table 1).

2. Plant Specimen Collections

The specimens of *Euphorbia hypericifolia* were collected in order to cover most habitats within the range of distribution of the species in Benghazi city from three different locations (Table 1). The specimens were identified through available literatures concerned with *Euphorbia*. The voucher specimens were kept at Botany Department (Herbarium of Cyrenica CHUG), Faculty of Science, Benghazi University (Figure2).

3. Seeds and capsule morphology

Seeds were preliminarily observed with a stereomicroscope to ensure that they were of normal size and mature. Seed dimensions' length, width was measured, and the L/W ratio was calculated to determine seed shape and subsequently describe the surface ornamentation patterns according to different studies [10; 11; 12]

4. Statistical analysis

The data were analyzed use SPSS, One-Way Analysis of Variance (ANOVA). Data are presented with means and standard deviations. The statistical significance by analysis of variance (one-way ANOVA), to analysis the relationship between different parameters, were also used comparing the three locations for each parameter.

Table 1. Details of three locations in Benghazi city

Locations	GPS Coordinates (Decimal Degrees)	Collection Date	Habitat/Altitude
Al-Fuwaihat pepsi street	N= 32 ° 07.82'980" E = 20 ° 08.32'160"	25/9/2025	annual herb
Jamal Abdel Nasser Street	N= 32 ° 110'.766" E = 20 ° 07.00'520"	20/10/2025	annual herb
Bu Snieb	N= 32 ° 03'.360" E = 20 ° 08'. 326"	12/9/2025	annual herb



Figure 2: Voucher specimen of *Euphorbia hypericifolia* L. collected in Benghazi city.

Results and discussion

The observations of *Euphorbia hypericifolia* L. in three new different locations in Benghazi establishes a new distributional record for this species in Libya. The cyathium, as a very developed pseudanthium, provides the real stage for the single female flower, whose stalk (gynophore) elongates theatrically after fertilization [13]. This structural feature ensures the developing into regma (capsule) is thrust outside the involucre, which is vital for the capsule to suitably mature, dry, and build internal hygroscopic tensions [8](Figure 3). This tension, assembled into the fruit features, is the mechanical engine for primary dispersal (Ballochory), the explosive force that dispersal the seeds several meters away from the parent plant. This efficient of ejection successfully completes the first stage of the species, seed dispersal mode (Diplochory). For the (*Euphorbia hypericifolia* L.), the ecarunculate structure of the seed [14]. that means this primary mechanical dispersal is the only real distribution method, making the structural reliability derived from the cyathium essential for its reproductive success. Dispersal mechanism (ballochory/explosive dispersal) is not completely reliable with the reason for the plant's record in Benghazi, as the species was first recorded in Libya in the city of Tobruk [15]. Study on two Mediterranean species of Euphorbia (*Euphorbia boetica* and *E. nicaeensis*) reported, that seeds were explosively launched maximum distance of 8 meters [16]. This mode of powered dispersal, which is characterized by rapidity and short range of facilitates its effective spread, is not explaining its establishing and ensuing observation in Benghazi subsequent its initial recording in Tobruk. In this regard, Tobruk and Benghazi are 500 kilometers. Euphorbiaceae exhibits a remarkable range of dispersal strategies, from explosive mechanism to adaptations for travel by wind, water, animals and human [16; 17]. Thus, the reason behind its new distribution is by human.



Figure 3. The three-lobed capsule (regma), with glabrous, smooth to minutely rough surface.
The photo taken by the author.

The results in (Table 2) referred to seed micromorphology of *Euphorbia hypericifolia* L. and the terms adopted in the description of reference [14] and [18].

The seeds shape was generally narrowly ovoid and tetragonal (four-angled) in cross-section. The seed dimensions were 0.681- 0.744 mm x 0.429- 0.549 mm, with averaging 0.715 mm in length and 0.496 mm in width, and the average of length/width ratio was 1.447, the shape of seeds is broadly elliptic to elliptic and quantitatively confirms the classification as broadly elliptic to elliptic, a normal biometric finding in regional floras [18]. The color varied from dark reddish-brown or brownish. The surface ornamentation is slightly wrinkled or transversely furrowed, featuring shallow, irregular transverse ribs. (Figure 4. a). According to reference [14], the shape is narrowly oval and tetragonal (four-angled) in cross-section, which are important characteristics that have been documented for species in the subgenus Chamaesyce. The dimension's average 0.715 mm in length and 0.496 mm in width. Additionally, the literature regularly uses the descriptive characteristics such as the dark reddish-brown color and the unique micro morphological feature of being slightly wrinkled or transversely furrowed, featuring shallow, irregular transverse ribs to distinguish this species from other, more highly ornamented species.

The capsule is typically three-lobed and possesses a surface that is described as glabrous (smooth) to minutely rough surface (Figures 2 and 3b). The shape is generally considered globose (near spherical), as the average (L/W Ratio) across all locations is close to 1.0mm (Table 3); its similar morphological characteristics, which concur with Webster [8]; Stearn, [11]; Sciandrello et al., [14]; Khamar et al., [19] and Vural et al., [20], with the seed measurements recorded in Benghazi.

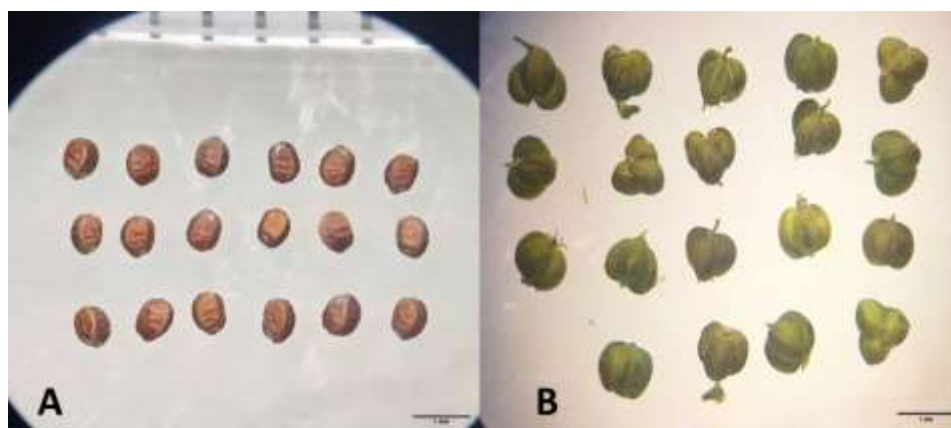


Figure 4. a & b. Stereomicroscope micrograph seeds and capsule of *Euphorbia hypericifolia* L.
The photo taken by the author.

The descriptive statistics for the 30 seeds, grouped by locations, reveal slight yet informative differences in size and shape across the three Benghazi locations. In terms of Length, Bu Snieb recorded the highest mean (0.7158 mm) and Jamal Abdel Nasser Street the lowest (0.7058 mm), yet all sites displayed high homogeneity, as indicated by the consistently low standard deviation (SD 0.019 - 0.024). The Width parameter showed a slightly higher degree of variation across all groups (SD) approx. (0.038 - 0.042), with Bu Snieb exhibiting the largest mean width (0.5247 mm). Finally, the L/W Ratio, which describes seed shape, suggests that seeds from Jamal Abdel Nasser Street are, on average, the most elongated (Mean 1.4050), though this site also recorded the highest (SD) for the ratio (0.1009mm), suggesting the greatest intra-site variability in seed shape, (Table 2).

Table 2. Mean and Standard Deviation of Seed Morphometric Parameters of *Euphorbia hypericifolia* L.

Locations	No. (Seeds)	Parameter	Mean (mm)	Standard Deviation (SD)
Al-Fuwaihat pepsi street	10	Length (L)	0.7139	0.0193
		(W) Width	0.4935	0.0406
		L/W Ratio	1.3920	0.0720
Jamal Abdel Nasser Street	10	Length (L)	0.7058	0.0192
		(W) Width	0.5022	0.0388
		L/W Ratio	1.4050	0.1009
Bu Snieb	10	Length (L)	0.7158	0.0239
		(W) Width	0.5247	0.0424
		L/W Ratio	1.3850	0.0918

Study of the capsule dimensions shows distinct patterns influenced by the three locations. Al-Fuwaihat pepsi street produced capsules with the largest mean Length (0.7904 mm) and Width (0.8940 mm), but also exhibited the highest standard deviation in Length(0.0950mm), representing more size variation at this site. Conversely, suggesting the capsules are both consistently large and highly uniform in size at this specific location. The L/W Ratio remained close to 1.0 (indicative of a globose shape) across all sites, with Jamal Abdel Nasser Street recording the highest (SD 0.1170), meaning the capsule shape is most variable at that site, (Table 3).

Based on the One-Way ANOVA performed on the raw data (comparing the three locations for each parameter), showed seeds low F-statistics for both Length ($F = 1.9567$) and L/W Ratio ($F = 0.0864$) yielded high P-values (> 0.05). This indicates that the observed differences in mean seed size and shape between the three Benghazi locations are not statistically significant and are likely due to random chance. While The Length of the capsules produced a higher F-statistic ($F = 4.3164$) with a P-value of 0.0232. Since this P-value is less than 0.05, it confirms that the difference in mean capsule length among the three locations is statistically significant. The L/W Ratio for capsules was not significant ($F = 1.1398$, $P=0.3340$).

Table 3. Mean and Standard Deviation of capsule Morphometric Parameters of *Euphorbia hypericifolia* L.

Locations	No. (Capsule)	Parameter	Mean (mm)	Standard Deviation (SD)
Al-Fuwaihat pepsi street	10	Length (L)	0.7904	0.0950
		(W) Width	0.8940	0.0766
		L/W Ratio	0.8820	0.0636
Jamal Abdel Nasser Street	10	Length (L)	0.1030	0.7439
		(W) Width	0.0729	0.8255
		L/W Ratio	0.1170	0.8900
Bu Snieb	10	Length (L)	0.0526	0.7384
		(W) Width	0.0898	0.8889
		L/W Ratio	0.0991	0.8580

The diversity in Euphorbiaceae' seed dispersal methods reflects adaptations to different ecological niches. Many Euphorbiaceae species in open or arid environments have evolved adaptations for wind dispersal (Anemochory). These typically involved modifications to reduce fall rate, such as winged seeds, hairs, or plumes [16; 17]. A floristic study in a semi-arid Brazilian region, found anemochory to be the second most common dispersal method after autochory, which included Euphorbiaceae [17].

While Tubrok, in which this species was first recorded, and it is far around 500 kilometers from the study area, this method can be not applying on its distribution in new locations of Benghazi city. Therefore, anthropochory, when seeds are moved by human (whether by planting, getting stuck on a shoe, or traveling in contaminated grain) explained the new distribution of *Euphorbia hypericifolia* L. in Libya. Agrochory is one of important methods in seed dispersal. It is an accidental transport of seeds by the tools or machinery, in addition, seeds in soil can translocate from site to other. This might have hypothesized and explain the dispersal of *Euphorbia hypericifolia* L, because of introduced plants from the neighbor country in east part of Libya.

Despite the long distance between the two cities (500 kilometers), it appeared clearly in the new study area in three different locations. We suggest this plant can be also distributed in other sites of the country. Therefore, we recommended to study its distribution in west and south of Libya as further work.

Conclusion

This study confirms *Euphorbia hypericifolia* L. as a new distributional record for Benghazi, Libya, extending its known range approximately 500 km west of its first Libyan record in Tobruk. The extreme distance between the two locations rules out its natural method (ballochory) as the cause method of its spread to Benghazi. Morphometric analysis of seeds and capsules from three Benghazi sites revealed minor, statistically insignificant variations in seed traits, but significant difference in capsule length among locations, suggesting possible local environmental influence on fruit development.

The primary driver for this new distribution is concluded to be human-mediated dispersal (anthropochory), via contaminated soil, agricultural machinery, or introduced plant material. *Euphorbia hypericifolia* L. may be present in other parts of Libya, warranting further distribution studies in the western and southern regions of the country.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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