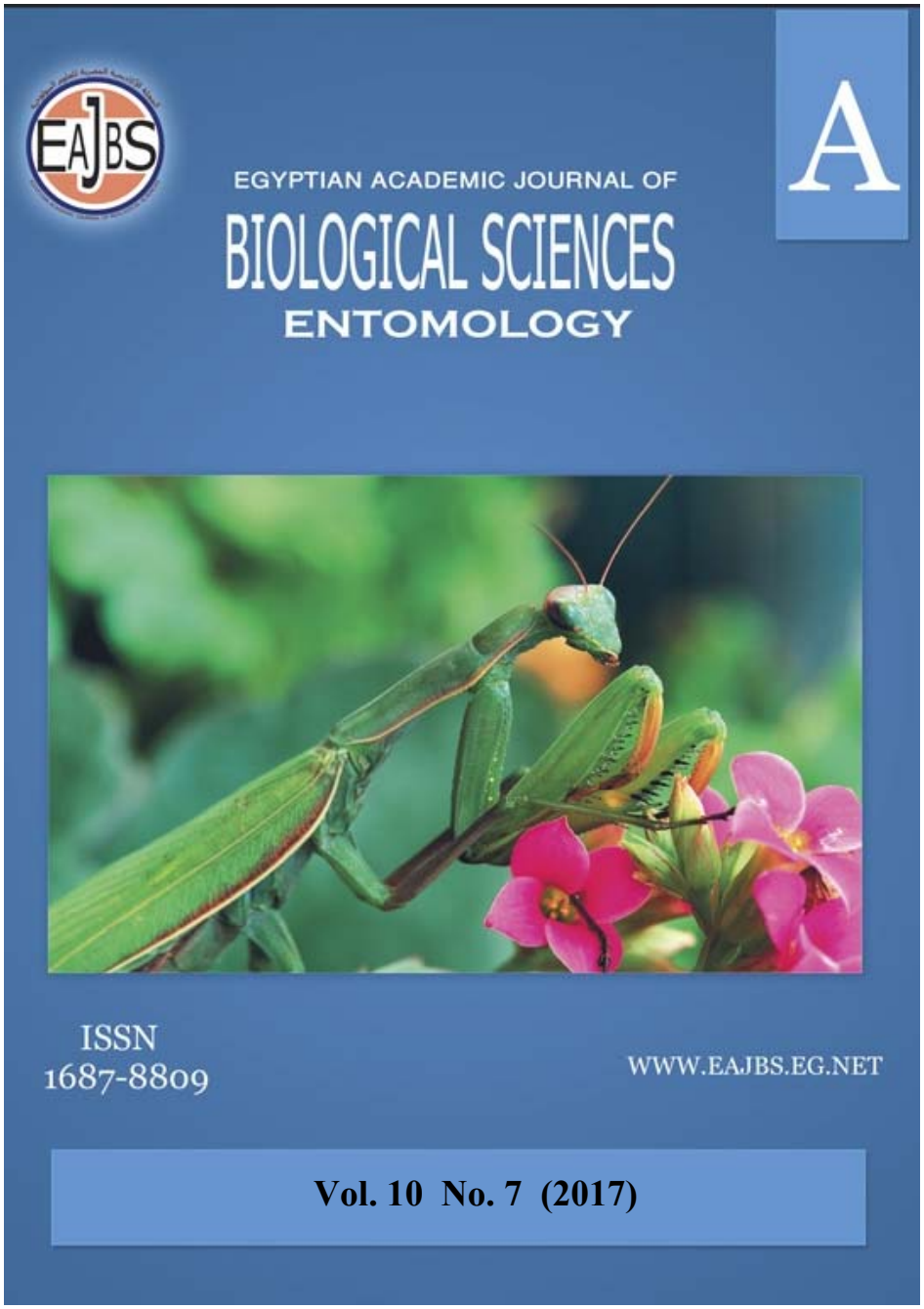

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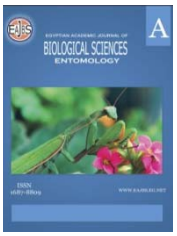

Incidence of Anobiid Boring Beetles (Coleoptera: Anobiidae) Attacking Furniture and Seasoned Wood in Egypt and Trials for Their Control.

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ABSTRACT

Family Anobiidae or death-watch beetles is a coleopteran woody-injurious important family joined to superfamily Bostrichoidae which mainly devastates wooden articles and furniture and its products. Through this study a survey for these wood boring pests was undertaken in 8 Egyptian governorates; Alexandria, Damietta, Fayoum, Giza, Ismailia, Matrouh, Port Said and Sohag representing 5 different geographical regions of Egypt and 30 locations were visited at those governorates for that investigation. Two coleopterous anobiid boring beetles; the furniture beetle, *Anobium punctatum* (DeGeer) and the death-watch beetle, *Nicobium castaneum* (Olivier) were recognized in 16 and 8 surveying localities, respectively and their damage and infestation levels were determined. Laboratory screening experiments were provided with tested preparations of crude extracts of neem seeds *Azadirachta indica* A. Juss (Sapindales: Meliaceae), commercial Neemazal and Cidial pesticide for both remedial and protective targets. Neem extracts were mainly generated from organic solvents such ethanol and petroleum ether. Percentages of mortality and repellency rates were observed. A significant high protection level was achieved scoring 79.3 and 81.3 % for *A. punctatum* and *N. castaneum*, respectively while average mortality rates were 83.6 and 85.3 % for these two anobiids, respectively. Results of the laboratory tests encouraged a series of applied trials at the natural attacked localities to be undertaken comparing their efficiency.

INTRODUCTION

Wood and its wooden derivatives are from the major and oldest tools since the beginning of the mankind history which is of great importance to the human usage all over the whole world with consideration of its great socioeconomic need. It is widely extracted and produced mainly from woody trees throughout all the world countries and is considered as a strategic product that provides many impacts on national income index through industrial, agricultural, trade, and commercial exchange as import and export activities influencing the economy parameters (Colak *et al.*, 2006).

The wooden articles including furniture, antiques, and seasoned wood are quite subjected to the infestations of several insect pests which are so-called wood-boring pests; orders Isoptera and Coleoptera with its boring families are the most common and widely distributed devastating wood boring pests. Among these coleopterous borers there is a wide distributed category called the powder-post beetles which is mainly included in Lyctidae and Anobiidae families. Seasoned and wooden articles and products are suffering from the extensively dangerous attacks of the different anobiid borers in extremely the all regions over the world especially the Mediterranean basin countries including Egypt. In Egypt these Anobiid boring pests are abundant and widely distributed attacking the furniture and industrial wooden products causing serious damage leading to great loss of costs (Alfieri, 1976; *Darles et al., 2013; Child and* Pinniger, 2014; and Roy and Joy, 2014).

Through the past decades just the chemical control measures and pesticides have been used to control these boring insects with no application of alternative tools or compounds. These restricted chemical treatments were insufficient for those powder-post anobiids control in addition to their high expenses and hazards for human and beneficial arthropods. Thus, alternative control measures such as plant extracts and their derivatives versus such dangerous boring beetles are encouraged to be applied. Neem tree, *Azadirachta indica* A. Juss (Sapindales: Meliaceae) is one of the common plant tree which its extracts products are using on a large scale and have applied against a wide range of insect pests worldwide including wood boring pests with a limited attention for such anobiid powder post beetles especially in Egypt. Neemazal, a brand product of neem, is also commonly known with its successful usage thus this brand was experimentally tested against the recorded Anobiid borers through the present study (Helal, 1981; Schmutterer, 1990; Sittichaya and Beaver, 2009; Pant and Tripathi, 2011; Kumar *et. al.,* 2012; and Hagstrum and Phillips, 2017).

In addition to investigate the existence and distribution of the wood anobiid boring pests attacking the seasoned wood furniture and other different wooden articles throughout the different localities at several Egyptian governorates during 2015-2017, a special attention to the infestation levels of the recorded anobiid borers through the visited locations was addressed through the present study. A series of laboratory experiments and applied trials with the crude extracts of neem seeds and a commercial Neemazal brand were also tested against those anobiid borers for both protective and remedial purposes. A comparative standard application with the recommended Cidial insecticide was additionally provided.

MATERIALS AND METHODS

Survey, collection, and identification of anobiid borers:

Periodical and continuous survey visits were done for detection the anobiid infestations, sampling of infested cuttings, and estimation of infestation levels throughout 30 locations at 8 governorates representing 5 different regions in Egypt during 2015-2017. These governorates were Alexandria, Damietta, Fayoum, Ismailia, Giza, Matrouh, Port Said and Sohag covering the five regions; Canal, East Delta, Mid Egypt, Upper Egypt and West Delta.

This positioning survey was done to investigate the presence and incidence of anobiid-boring pests infesting the furniture articles and seasoned wood. Observed wooden parts attacked by these powder-post beetles were investigated then the possible and available obtained borers and wooden samples were collected to the

laboratory, securely preserved in glass jars for further adult identification, laboratory screening experiments. Obtained sampled adults were initially identified according to Alfieri (1976) and Arnett *et al.* (2002) by staff members of Classification and Taxonomy department at Plant Protection Research Institute, Dokki, Giza in Egypt. Then this identification was furthermore confirmed to the same findings through Bousquet (1990) and sheet of Natural History Museum (2014) by staff members of Classification unit, Entomology Department, Faculty of Science, Cairo University.

Detection of infestation rates:

Collected wooden samples were preserved and secured in glass jars and then prepared to the usage for laboratory experiments. Infestation rates with the identified boring pests were estimated for each of their own existing locations during 2015-2017.

Preparation of neem extracts:

Neem seeds, *Azadirachta indica* A. Juss (Sapindales: Meliaceae) which contain the active compound "Azadirachtin" the well-known ingredient, were gained with the aid of Mr. Sing Galbahai (Supervisor of Al-Shrouk farm in Egypt) [Personal communication]. Ethanol and petroleum ether were prepared for usage as solvents. Obtained seeds were weighed, crushed, and grinded into a powder then this powder was divided into serial groups of 4, 2, 1 gm. For preparation of the desired concentrations series, those groups were distributed, mixed with a definite volume (1liter) of each desired solvent, and skimmed of supernatant according to Ascher (1981).

Laboratory screening experiments:

These crude extracts were used separately for laboratory screening experiments. Laboratory experiments were designed for remedial and protective techniques tests against the identified anobiid borers. To achieve the required results infested seasoned wood were sawn to cuttings of 15cm long with almost the dimensions and five replicates were used for each treatment.

a-Protective technique (repellency):

To study the repellent effect of these extracts, intact wood cuttings were prepared and were subjected to a release of anobiid beetles through attacked adjacent wood cuttings altogether in the same jars, and then rates of infestation degrees were observed for all the treated replicates meanwhile repellency was achieved.

b-Remedial technique:

Testing the toxicity efficiency of neem extracts needed already infested wood cuttings to estimate the remedial effect through the recorded readings of emergence rates within the used replicates jars. A recommended registered chemical insecticide Cidial L50% was applied as a comparison index in addition to a commercial brand of Neemazal extract product at the same rate. Positive control checks were just tested by spraying only the responding solvent at the same rate of treatment. All laboratory experiments were done under the natural environmental conditions of the laboratory 25±5 C^o and 65±10 RH. Rates of attack and emergence at equal time intervals were recorded and the promising titers of each treatment were chosen for the further field applications.

Applied trials:

Successful and effective titers of neem extracts, Neemazal and Cidial applications in laboratory experiments against those anobiid wood borers were provided as a standard reference for the applied trials at Port Said locality; the location of highest infestation level for both tested anobiid borers, in Port Said governorate within the Coastal region of Mediterranean shore.

Levels of infestation reduction due to these trials treatments against both target anobiids beetles were determined by Henderson and Tilton (1955) formula.

Statistical analysis:

Observed mortality rates were corrected by Abbott formula (1925). Gained data were statistically analyzed and lethal times and toxicity lines were estimated by the log-time probit model using the LdP Line software.

RESULTS AND DISCUSSION

Wood-boring species attacking furniture and seasoned wood:

Table (1) shows the identified wood-boring species that attacked the furniture articles, seasoned wood and wooden products at the different visited localities through the Egyptian regions during 2015-2017. Sampled adults were classified to genus *Anobium* and *Nicobium* of family: Anobiidae belonging to order: Coleoptera. Those boring species are: the furniture beetle, *Anobium Punctatum* (DeGeer) and the death-watch beetle, *Nicobium castaneum* (Olivier); both these two boring pests are mainly belonging to the family Anobiidae in order Coleoptera as their ultimate identity is addressed in Table (1). This finding is similar to those of Alfieri (1976) in Egypt, Philips (2002) in North Carolina and Viñolas and Masó (2007) confirming the genera of Anobiidae family.

Table (1): Anobiid Wood-boring species infesting seasoned wood at different localities and regions in Egypt throughout 2015-2017.

Systematic position			**Anobiid borer species**	
Order	**Family**	**Sub Family**	**Scientific name**	**Common name**
Coleoptera	Anobiida	Anobiinae	*Anobium Punctatum* (De Geer)	Furniture beetle
		Ptininae	*Nicobium castaneum* (Olivier)	Deathwatch beetle

Occurrence of the identified anobiid borers' species:

Distribution and occurrence of the identified anobiid boring species throughout the visited localities in the different regions in Egypt during 2015-2017 are shown in Table (2). Results revealed that Damietta (East Delta region) and Port Said (Canal Region) governorates have the highest number of the attacked localities recording 4 localities in each governorate for the infestation with *A. Punctatum* meanwhile this figure for *N. castaneum* was in Damietta governorate and Alexandria governorate (West Delta region) recording just 3 localities. On the other hand, results of Table (2) showed that Sohag governorate (Upper Egypt Region) has no attack through its visited localities. Through this present positioning study the furniture beetle, *A. Punctatum* showed a wide spread distribution more than that of the deathwatch beetle, *N. castaneum* through the all attacked localities recording 16 existing localities whereas the other anobiid borer was just found in 8 localities. This finding matches with observations noticed by Spencer (1947), Christopher *et al.* (2007) and Unal *et al.* (2009) as those anobiid boring beetles were recorded extensively attacking seasoned wood causing serious damage.

Obtained results also elucidates that both *A. Punctatum* and *N. castaneum*

seems to prefer their natural infestations settlement through the costal geographical distribution regions and further condensed ecological studies for this overall conclusion should be encouraged. This observation is concisely matching with those of Helal (1981) who explained how temperature and humidity levels affect post-powder beetles' attacks and Abdelghany *et al.* (2010) who confirmed the critical importance of the temperature range for the anobiid infestations.

Table (2): Anobiid wood boring pests occurrence at different localities and regions in Egypt during 2015-2017.

Region	Governorate	Locality	Anobiid species*	
			A. punctatum	*N. castaneum*
Canal Zone	Ismailia	Al-Qntra Gharb	-	-
		Al-Qntra Sharq	-	-
		Fayed	+	-
	Port Said	Al-Kab	-	-
		Al-Gameel	+	+
		Port Fouad	+	-
		Port Said	+	+
		Sahl Al-Tena	+	-
East Delta	Damietta	Damietta	+	+
		Faraskour	+	-
		Raas Al-Br	+	+
		Shatta	+	+
Mid Egypt	Fayoum	Ebshaway	-	-
		El-Eslah	+	-
		Ettsa	-	-
		Senoris	-	-
		Youssef Al-Sedeeq	-	-
	Giza	Abou Rawash	+	-
		Al-Haram	-	-
		Al-Mansoureia	+	-
		Dokki	-	-
		Embaba	-	-
Upper Egypt	Sohag	Akhmim	-	-
		Gerga	-	-
West Delta	Alexandria	Abou Keer	-	-
		Al-Amria	+	+
		Al-Raml	+	+
		Mamoura	+	+
	Matrouh	Matrouh	+	-
		Wadi Al-Notroon	-	-

* (+) indicates to the presence of anobiid borer; (-) indicates to the absence of the anobiid borer

Infestation levels of the anobiid wood borers:

Infestation levels with these two boring pests are shown in Figs 1&2 represented by the degrees of infestations observed throughout the attacked localities

in different regions of Egypt during 2015-2017 seasons. The gained Results revealed that the Port Said locality in Port Said governorate (Canal region) is the broadest attacked locality with both *A. Punctatum* and *N. castaneum* recording average infestation degrees reached 45.3 and 32.7 hole/cutting, respectively. On the other hand, El-Eslah locality in Fayoum governorate (Mid Egypt region) was found to show the lowest infestation degree with *A. Punctatum* recording 3.67 hole/cutting on average while for *N. castaneum*, the least average infestation degree was observed at Rass Al-Br location in Damietta governorate (East Delta region) scoring 16.3 hole/cutting**.**

Both the two anobiid borers *A. punctatum* and *N. castaneum* were significantly recorded in high average level at P>0.05 according to Duncan's multiple range test through the Port Said location (Port Said governorate) scoring 45.33 and 32.67 hole/cutting respectively for the two boring pests. In addition to these gained results and as the previously observations through the positioning survey for the anobiid borers thus ultimate choice for Port Said locality for further applied control trials against these anobiid borer species was suggested.

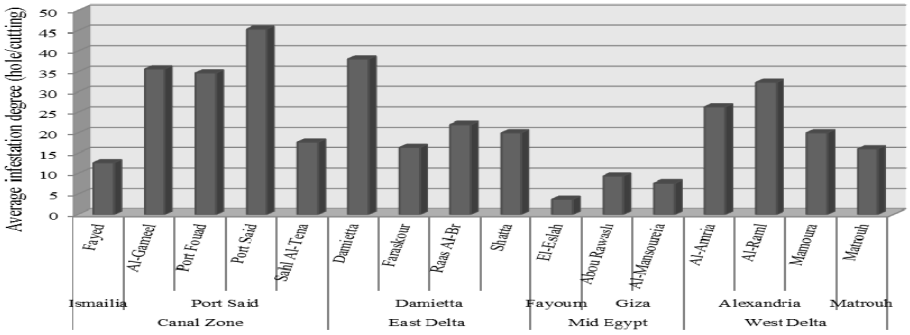

Fig. (1): Levels of infestation degree with *A. punctatum* attacking seasoned wood throughout different regions in Egypt during 2015-2017.

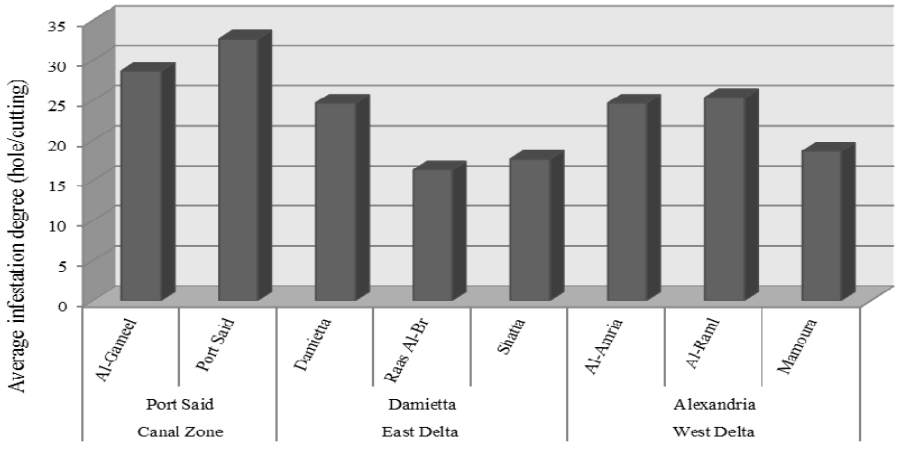

Fig. (2): Levels of infestation degree with *N. castaneum* attacking seasoned wood throughout different regions in Egypt during 2015-2017.

Laboratory screening tests:

Figs. 3&4 show the effect of the different lethal concentrations of neem extracts; for ethanol and petroleum ether solvents and Neemazal commercial brand in addition to Cidial insecticide when applied against the anobiid borers; *A. punctatum*

and *N. castaneum* in the laboratory. Treatment applications were undertaken either on intact wood cuttings for protective target or on infested ones for the remedial purposes.

A-Protective technique:

Fig. (3) elucidates that the intact wood cuttings got a significant high protection level against the attacks of both those anobiid borers at P>0.05 when Cidial insecticide was sprayed revealing a highest level of repellency reached 79.3 and 81.3 % on average for *A. punctatum* and *N. castaneum* beetles, respectively. These repellency rates were effectively accompanied with the lowest lethal titers of LC_{50}, LC_{90}, and LC_{99} scoring 1.176, 2.814 and 9.608 gm/ml, respectively. Far of Cidial and Neemazal results, ethanol neem extracts had a reasonable repellency against the attacks of both the two anobiid beetles. It was found to be the most repellent neem preparation resulted in average 39.7 and 41.7 % repellency with significant lethal titers (at P>0.05) of LC_{50}, LC_{90}, and LC_{99} reached 3.124, 19.854 and 41.366 gm/ml, respectively.

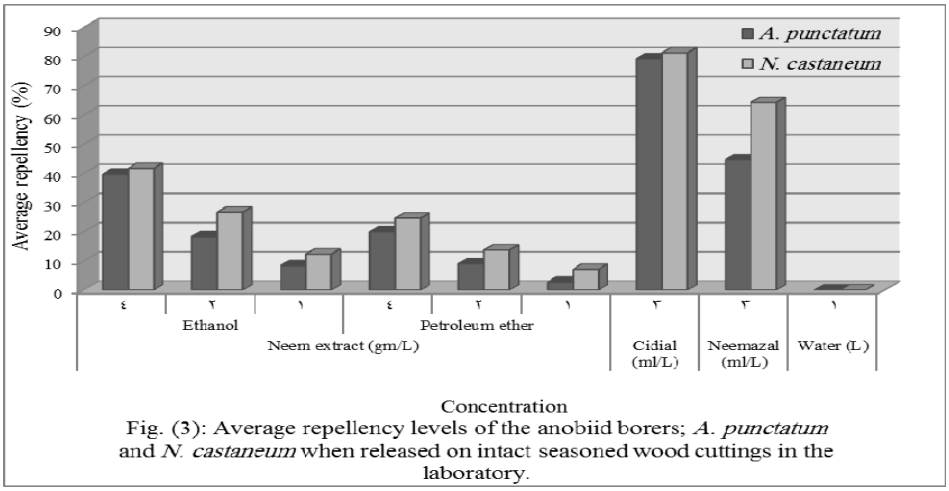

Fig. (3): Average repellency levels of the anobiid borers; *A. punctatum* and *N. castaneum* when released on intact seasoned wood cuttings in the laboratory.

B-Remedial technique:

Similarly to the obtained results of protective tests against these two wood boring anobiids, Fig. (4) shows infestations with these borers were significantly at P>0.05 affected by Cidial treatments recording average mortality rates of 83.6 and 85.3 % for *A. punctatum* and *N. castaneum* beetles, respectively this was accompanied with the lowest rates of LC_{50}, LC_{90}, and LC_{99} scoring 1.865, 3.248 and 9.935 gm/ml, respectively. Also, ethanolic neem extracts achieved lesser effective mortality rates with significant lethal titers (at P>0.05) were 6.932, 27.867 and 83.445 gm/ml, respectively for LC_{50}, LC_{90}, and LC_{99} values.

Obtained results show that the ethanolic neem extracts especially the titer of 4 gm/L which revealed a considerable efficiency against the infestations of the anobiid borers whereas those extracts of petroleum ether got a limited effect. These results are matching with those of Jaglan *et al.* (1997) who reported that methanol neem extract concentrations were used successfully treating wood cuttings. On the other hand, the results confirmed the potential effect of Cidial insecticide and Neemazal brand. Thus, these effective elements with their efficacious concentrations were selected for the forthcoming applied trials.

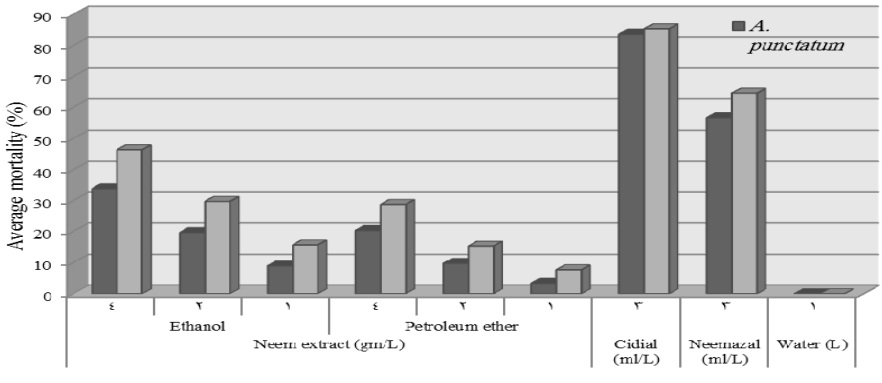

Fig. (4): Average mortality levels of the anobiid borers; *A. punctatum* and *N. castaneum* when treated on attacked seasoned wood cuttings in the laboratory.

Applied field trials:

Fig. (5) shows the average reduction of infestation with the anobiid boring pests; *A. punctatum* and *N. castaneum* as a result of the applied trials with ethanolic neem extract, Neemazal and Cidial compounds on infested seasoned wood articles at Port Said locality in Port Said governorate. Ethanolic neem extracts revealed average reductions of infestations with *A. punctatum* and *N. castaneum* reached 19.6 and 13.3 %, respectively meanwhile this figure of the infestation reduction with Nemazal was 37.67 and 40.33 % on average. Cidial treatments resulted in the highest levels of infestation reduction scoring 81.79 and 82.3 % against *A. punctatum* and *N. castaneum*, respectively and its treatments at P>0.05 revealed the highest average significant reduction level.

The obtained results through the laboratory experiments and the applied field trials elucidated a significant reduction of infestation for these two anobiid borers; *A. punctatum* and *N. castaneum*. Levels of infestation reduction in the applied field trials for both separate Neemazal and Cidial applications were not significantly different at P>0.05 for their similar results in the laboratory experiments. On the other side, the levels of infestation reduction caused by ethanolic neem extracts through the laboratory tests were significantly different at P>0.05 in relation to their revealing results in the applied trials. These findings with the insecticidal treatments agree with those of Child and Pinniger (2014) on the detection and remedial applications against the anobiid furniture beetle, *A. punctatum*. Provided results are concordant with those of Roy and Joy (2014) as neem ethanolic extracts were effective to reduce and control *A. punctatum* attacks recommending it for its control applications. Thus neem extracts could be improved to attain more promising control results against these anobiid borers meanwhile titers of Neemazal treatments may be reviewed to increase their efficacious goals the matter which encourage its usage against those boring pests.

Foregoing results through this study tried to focus on the existence and distribution of the anobiid wood boring pests that attack furniture and seasoned wood articles throughout the different regions in Egypt addressing an alert for their positioning range. Additionally, it aimed to furnish a figure for the occurrence and infestation levels of the recorded anobiids; *A. Punctatum* and *N. castaneum* the most destructive anobiids attacking the wooden articles providing a series of control experiments influent to the dominance programs against such wood anobiid beetles maintaining the wood productivity and trade in Egypt.

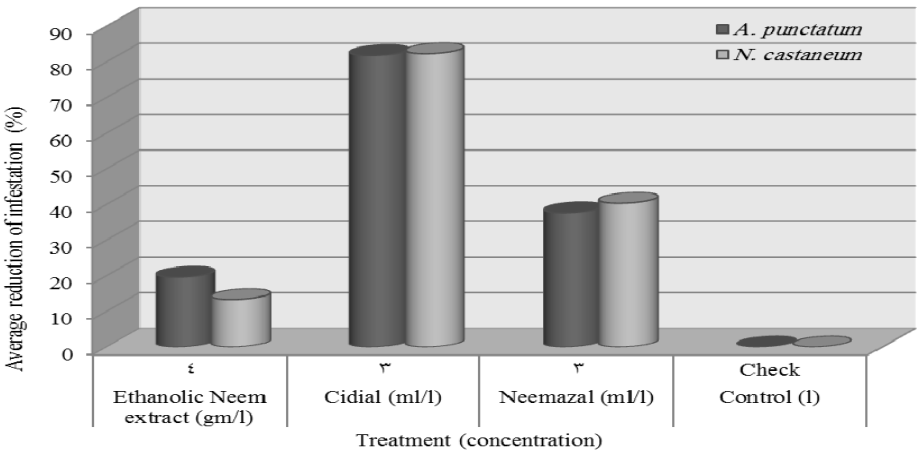

Fig. (5): Average reduction of infestation with *A. punctatum* and *N. castaneum* when treated on attacking seasoned wood at Port Said location

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ARABIC SUMMARY

مدى الأصابة بناخرات خنافس الأنوبييدى المهاجمة للأثاث والأخشاب المصنعة فى مصر مع محاولات لمكافحتها

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١-قسم بحوث الناخرات و النمل الأبيض– معهد بحوث وقاية النباتات– مركز البحوث الزراعية – الدقى – جيزة – مصر
2-قسم الكيمياء العضوية – كلية العلوم – جامعة القاهرة – جيزة – مصر

عائلة أنوبييدى من عائلات غمدية الأجنحة الناخرة و المهلكة للأخشاب و هى تنتمى لفوق عائلة بوستريكويديا و المعروفة بقوتها الإهلاكيه للمواد الخشبية و الأثاثات و لذا يطلق على أفرادها الخنافس الساحقة ، من خلال هذه الدراسة تم عمل مسح لهذه الناخرات فى ثمانية محافظات بجمهورية مصر العربية و هى الأسكندرية و دمياط و الفيوم و الجيزة و الإسماعيلية و مطروح و بورسعيد و سوهاج ممثلة للمناطق المصرية الجغرافية المختلفة و من خلالها تم زيارة 30 موقع لإجراء هذا الفحص ، و لقد تم التعرف على خنافس الأنوبييدى الناخرة فى سبعة من إجمالى المواقع التى تم مسحها و من ثم تم تحديد حجم الضرر و مستويات الإصابة ، ثم أعقب هذا المسح تجارب الفحص المعملية لإختبار مدى فعالية بعض المركبات مثل مستخلصات بذور النيم الخام و مركب النيمازال التجارى بالإضافة لمبيد السيديال. و لقد تم تحضير المستخلصات بالإستعانة بثلاثة مذيبات عضوية منفصلة كل على حدة بالإضافة لمستخلص مائى لتلك البذور ثم تم حساب النسب المئوية للطرد و الإماتة ، و لقد تم رصد أعلى مستوى حماية ناتج عن الطرد بلغ 79.3 و 81.3 % بالنسبة لكل من *A. punctatum* و *N. Castaneum* على الترتيب ، بينما كان متوسط نسب الإماتة 83.6 و 85.3 % لكلا من هذين الحفارين على الترتيب ، ووفقا لنتائج التجارب المعملية تم تنفيذ معاملات تطبيقية فى أماكن الإصابات الطبيعية و من ثم تم اتباع ذلك إجراء مقارنة إحصائية بين المعاملات المختلفة لتحديد المعاملة الفعالة.