THE DISTRIBUTION AND BIONOMICS OF KUHL'S BAT, *Pipistrellus kuhli kuhli* (Natterer in Kuhl, 1819), IN LEBANON (Chiroptera: Vespertilionidae)

by

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THESIS

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THE BIONOMICS OF *P. k. kuhli*

STENCEL

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ABSTRACT

During the past year, the author has collected data pertaining to the distribution and natural history of Pipistrellus k. kuhli in Lebanon. These bats are commonly found in colonies, inhabiting the cracks and crevices of old buildings throughout Lebanon. They exhibit two distinct flight patterns. When approaching a distant area, they fly very high, out of gun shot, in a linear position. While feeding, their flight is usually low and erratic. In the winter, when food is scarce, each bat seems to select a feeding territory and prevents other bats from invading the area. During summer they feed in groups near rivers or open fields. They apparently prefer small dipterans and lepidopterans as food. Mating occurs in the fall and the sperms are probably stored in the uterus until spring when ovulation apparently occurs. Parturition begins in May with two born at a time. After the second year the young are sexually mature. During the winter their numbers are greatly reduced. Hibernation seems to be restricted only to a few very cold days.

The ectoparasites removed from P. kuhli included ticks, Nycteribiidae, mites and one siphonapteran.

It was noted that these bats exhibited a considerable color variation. Their pelages ranged from a silvery gray to dark brown in Lebanon. Those bats with more pallid colors might be better camouflaged against their predator, the black kite.

The external measurements of the European Pipistrellus kuhli were compared with those in Lebanon. It was observed that the European specimens were slightly larger in size, particularly in tail and ear lengths.

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In general, there is little known about the fauna of the Middle East. The author hopes to contribute some data about the distribution and bionomics of the white bordered bat, Pipistrellus kuhli kuhli (Natterer in Kuhl, 1819) in Lebanon (plate *I.* ,p. 23.).

P. k. kuhli was selected for study because it is extremely common in Lebanon. These bats are fairly accessible. They prefer to live in cracks and crevices of old buildings and usually feed nearby at dusk. Their feeding characteristic of usually flying low in some open area facilitates their capture.

II. Materials and Methods

To ascertain the distribution and bionomics of P. k. kuhli in Lebanon, the author selected 14 stations, evenly distributed throughout the country. A map showing the location of these stations is found on page 22 . Animals were observed or collected, if possible, at each station. In Beirut, there were several observation posts where bats were studied and captured.

The equipment used in capturing Kuhl's bats, was a 9 mm. shot gun and a bamboo pole. The shot gun was most effective. On one occasion in Tyr a young collector captured 3 bats. He swung an eight foot bamboo pole back and forth knocking them down from the air.

The external and cranial measurements of each bat were recorded and the mean and standard deviation determined. All of the 60 external measurements were taken from recently killed specimens. They included in millimeters, the total length, tail, hindfoot, ear, tragus, and forearm. The skulls were soaked in tap water for two days and then boiled for 10 minutes before cleaning. Afterwards, they were bleached in a

50%-Chlorox-50% tap water solution for about 5 minutes. The 30 skull dimensions, measured with a caliper in millimeters, include the greatest length, condylo-basal length, zygomatic breadth, breadth of braincase, inter-orbital constriction, maxillary teeth c-m, mandibular teeth c-m, and the length of the mandible.

The specimens were either skinned or preserved in 70% alcohol. Some specimens were sent to the British Museum (Natural History) for confirmation of their identification. Ectoparasitic hemipterans were identified by Dr. R.L. Usinger of the University of California, Berkley, U.S.A.

III. Historical

The original paper containing the description of P. kuhli was not available to me. G. Doria (1887), Anderson and de Winton (1902), and Allen (1939) mention 1817 as the earliest date for this species. It seems to have been described by Johann Natterer in an article written by Kuhl called "Deutschen Fledermause", Wetterau. Ann. Hanau, p. 55. Recent workers such as Ellerman, et. al. (1951) and Toschi and Lanza (1959), refer to the date of description as 1819. All agree that the type area is Trieste, a city on the Italian-Yugoslavian Border.

Below is listed a partial synonymy of this species.

1819 Vespertilio kuhlii, Natterer in Kuhl, Ann. Wetterau. Ges. Naturk. 4,2, p. 199.

1826 Vespertilio marginatus, Cretzschmar, in Rüppell's Atlas, Reise Nördl. Afrika, Zool., Säugeth. pl. 29a. p. 74.

1829 Vespertilio pipistrellus var. aegyptius, J.B. Fischer, Synops., Mamm. p. 105.

1835 Vespertilio albolimbatus, Küster, Oken's Isis, pt. 1, p. 75.

1837 Vespertilio vispistrellus, Bonaparte, Iconogr. Faun. Ital., I. fasc. 20.

1837 Vespertilio alcythoe, Bonaparte, loc. cit. fasc. 21 (see Miller, 1912, p. 215).

1838 Romicia calcarata, Gray, Mag., Zool., and Bot., 2, p. 495.

1840 Vespertilio ursula, Wagner, Schreb. Säugeth. Suppl. I, p. 505.

1841 Vesperugo marginatus, Wagner, Reisen. Regentsch. Alger., 1836-1838, p. 39.

1841 Pipistrellus marginatus, Bonaparte, Iconogr. Faun. Ital. Indic. dist. nomen. mod. substitute for albolimbatus.

1841 Pipistrellus kuhlii, Bonaparte, Iconogr. Fauna Italica, Introd., p. 2; Trouessart, Faune. Mammif., Europe p. 17, 1910; Miller, Cat. Mamm. West. Europe, p. 215, 1912; Cabrera, Fauna Iberica, p. 117, 1915.

1844 Vespertilio marginatus, Wagner, Schreb. Säug. Suppl. I. LV, p.503.

1845 Pipistrellus lepidus *, Blyth, J. Asiat. Soc. Bengal, 14, p.340.

1846 Vesperugo subtilis *, Sundevall, Öfversigt af Kongl. Svenska Vet.-Akad. Förhandl., Stockholm, 3: no. 4, p. 119.

1857 Vesperugo kuhlii, Blasius, Fauna. Wirb. Deutsch. p. 63; Cornalia, Fauna Italia, p. 17, 1874; Dobson, Cat. Chir. Brit. Mus. p. 230, 1878.

1863 Nycticeius canus, Blyth, Cat. Mamm. Mus. Asiat. Soc. Bengal, India, p.32.

1866 Vesperugo kuhlii, Tristram, Proc. Zool. Soc., p. 93.

1867 Pipistrellus vispistrellus, Loche, Expl. Sci. Algérie, Zool. Mamm. p. 77.

1867 Pipistrellus minuta, Loche, Ibid., p. 78.

1867? Scotophilus lobatus, Jerdon, Mamm. India, p. 35.

1872 Vespertilio (Pipistrellus) leucotis, Dobson, J. Asiat. Soc. Bengal, 41, p. 222.

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* Now considered to be subspecies.

1876 Vesperugo kuhlii, var. leucotis, Dobson, Blanford, Zool. East Persia, p. 23.

1886 Vespertilio kuhlii, var. albicans, Monticelli, Atti. Soc. Ital. Sci. Nat. 27, p. 200.

1886 Vespertilio kuhlii var. pullatus, Monticelli, loc. cit. p. 200

1900 Pipistrellus kuhlii, Mehely, Monogr. Chiropt. Hungariae, p. 261.

1901 Pipistrellus kuhlii fuscatus, Thomas, Ann. Mag. Nat. Hist. (7)8: p. 34.

1903 Vesperugo margine, Menegaux, Les Mammiféres, Paris: Bailliére, p. 153.

1924 Pipistrellus kuhlii ikhwanius, Cheesman & Hinton, Ann. Mag. N.H. 14, p. 549.

1936 Pipistrellus kuhlii pallidus, Heim de Balsac, Bull. Biol. Paris Suppl. 180, p. 21.

The world distribution of Pipistrellus kuhli is limited to Eurasia and Africa. The Canary Islands are its westward boundry. Doria (1887) reports it as far east as Mandalay, Burma. Kuhl's bats are concentrated around the mild Mediterranean Sea in southern Europe, the western coasts of the Middle East, some Mediterranean islands and northern Africa. They have been found as far north as Teheran, Iran and in the Russian Turkistan. The southern borders of its distribution end at Cape Province, the south African tip.

Ellerman, et. al. (1951) recognize four distinct subspecies of the Pipistrellus kuhli group. P. k. kuhli is found in southern Europe and on the Mediterranean islands of Corsica, Crete, Dalmatia, Sardinia and Sicily. It extends from Lebanon eastward to Russian Turkistan, Iran, Iraq, and Yemen. P.k. lepidus was first described from Kandahar, Afghanistan. It ranges to Kashmir and the upper Sind frontier. The type locality of P. k. ikhwanius is the town of Hufuf, Central Arabia.

P.k. pallidus extends from the northern Sahara to A'Haggar, Algeria. Allen (1939) mentions two other subspecies. P.k. fuscatus was reported in Naivasha, Kenya while P.k. subtilis was described from the interior of Kaffraria, Union of South Africa.

IV. Discussion

A. Distribution in Lebanon

In 1915, Allen captured a P. kuhli in (Shtora) Chtaura, Syria, now situated in Lebanon. Since that time, little work has been done to determine the distribution of this bat in Lebanon. The author has found evidence or has actually captured P.k. kuhli in 10 stations out of the selected 14. It seems reasonably certain from the geographic distribution of these 10 stations that the species occurs throughout Lebanon. It was noted that Kuhl's bats were found in greater numbers along the sea shore than further to the interior. These observations in Lebanon agree with those of Harrison (1955) made in Arabia. Bats were discovered at sea level in Tyr and in Saïda, and observed as high as 1450 meters in Ehden. Sanborn and Hoogstraal (1953) report that they were captured in Yemen at altitudes close to 2,150 meters in San'a and 2,240 meters in Ma'bar.

B. Bionomics

In 1885, Tristram discovered what he called Vesperugo kuhlii in caves near Bethlehem, Jordan. Harrison (1956) noticed that P. kuhli flew outside cave areas but was not seen roosting in the caves.

Anderson & de Winton (1902) report that La Taste observed this species inhabiting the top of palm trees in Algeria. H. Kahmann (1960a, b) has found them in similar places in Turkey, Morocco and Tunisia.

He also found them living in a hollow olive tree in a cultivated orchard in Greece. In 1903, Menegaux stated that they frequented the cliffs of the Mediterranean Sea and occurred on all sides of the Adriatic Sea. The habitat references for P. kuhli seem very diversified. In most cases, the white bordered pipistrelles prefer to live in cracks and crevices of buildings. In the coastal town of Sharjah in Oman, south-eastern Arabian peninsula, the houses are built of large coral bricks, cemented together with mud. Harrison (1955) found colonies of P. kuhli packed tightly together in the deep fissures between the bricks. During daylight, if someone approached their quarters they would reveal themselves by uttering angry squeaks. Anderson & de Winton (1902) mention that La Taste generally found only single individuals inhabiting a hole in a fort near Ourgla, Algeria. Dulić (1960) reports that P. kuhli roosts under tiles of roofs, in holes under roofs and in chimneys in Zagreb, Yugoslavia. In the summer they are particularly fond of areas near the warm kitchens of homes in villages and cities. In winter (Dec. 26th) Weber (1955) captured a specimen that had been resting torpidily in a roll of reed matting on the north side of a house.

In Lebanon the author has not observed this species in caves, in cliffs along the Mediterranean Sea, or in palm trees. During the summer of 1960 a large colony of them was found in a hole, situated between the right angle beams of the Mann building (Rue Clemenceau) in Beirut, illustrated in (plate II., p. 24.). The next building south contained a few individuals between the cracks under the window sills. In Amchîte they were seen issuing from the crevices between the boards

of a roofed balcony at dusk. In Barja several colonies were observed in crevices around old wooden window frames. One collector easily captured them in his hands as they crawled from the fissures during the early evening. In Halba there were great quantities of guano piled beneath the old doors of a church meeting house (plate III., p. 25.). Some bats lived in the cracks between the wooden door supports and the plaster wall.

There are two distinct types of flight observed in this species. The crusing flight is straight and high, usually in the direction of some feeding area. Their feeding flight, however, is extremely different. It consists of a low, meticulous canvass of the feeding territory with periods of radical change when an insect is spotted. Here their manuverability is amazingly rapid and is characterized by twists, dips and dives. Sanborn and Hoogstraal (1953) report that in Yemen, P. kuhli hawked the city streets in a low, darting, somewhat cumbersome flight squeaking as they flew 10 to 12 feet above the ground. In an orchard near the chemistry building on the campus of the American University of Beirut the author has seen them almost touch the ground in pursuit of an insect.

During the month of August (1960) in Zahle', Lebanon, Kuhl's bats were seen flying in small groups from the town. Their flight was in the direction of a spring two miles away which probably provided them with both water and a good feeding territory. They remained out of shotgun range except for an occasional dip to snatch a passing insect. Harrison (1955) noticed hundreds of P. kuhli flying high from the town of Sharjah across nearly a mile of barren desert to the vicinity of an

air field which probably was a feeding territory.

Feeding time usually begins shortly before sunset but on cloudy days they have been observed in late afternoon. Upon reaching a feeding territory the animal searches for insects at a considerable altitude. As darkness sets in it comes much nearer the ground. It probably follows the distribution of insects during this time. In winter the feeding period lasts about 15 to 35 minutes and in the summer it extends to about an hour. Individuals do not remain in the territory for the total feeding time. They apparently move on to another area or rest somewhere in the vicinity. In Zahlé during the month of August (1960) many bats were feeding together along the water courses. In winter, when insects are scarce, only one individual fed in the orchard on the campus of the American University of Beirut. Competition must have been great since other bats which entered the area were promptly chased out.

Kuhl's bats are attracted by lights and are usually found circling them, scooping up insects at night. Sanborn and Hoogstraal (1953) stated that P. kuhli frequented shops illuminated by kerosene pressure lanterns. Cheesman (1920a) referred to Ingoldby's observations, that reported these bats chasing insects around the lights of river steamers near Sheikh Saad, Yemen. These bats are common around the night lights on the campus of this University.

The diphyodontic teeth of this species are quite sharp and the molars are strongly convoluted and imbricated. They chew their food so well that it is practically impossible to identify their stomach contents. Gould (1955) warns that the identification of insects in the stomachs of bats does not give a true estimation of their food content since insects with soft bodies become an "unidentifiable soup". He stated that

Eisentraut noted that the smaller European bats of the family Vespertilionidae prefer dipterans and the smaller lepidopterans. On one occasion, the author discovered the head of an ant attached to a bat's fur.

As in other forms, copulation seems to occur during the months of September and October. Similar to the observations by Lanza (1956a,b) in Italy, the author noted that the testes were conspicuously large at this time. Lanza correlates the presence of the enlarged testes with the formation of a pair of fairly large buccal pads. They are located at the labio-gengival orifice at the level of the molars. These pear shaped structures are composed of adipose tissue. They are prominant in males during spermatogenesis. Lanza postulates that the buccal pad produces some glandular secretion, the odor of which functions as a sexual attractant during the mating season.

There is a question whether copulation occurs during flight or in the roost.

Anderson and de Winton (1902) and Lanza (1959) have observed a penus bone in P. kuhli. This supporting structure might aid in copulation.

Evidently the sperms are retained in the uterus during the winter. It was noted in February of 1960 that both uterine horns were large and conspicuous in some specimens collected on the American University of Beirut campus. The uteri were filled with a thin milky fluid. In one female that was inspected microscopically, the fluid was found to contain many active spermatozoa.

Asdell (1946) reports sperms clinging to the uterine walls throughout the winter months in P. pipistrellus (Schreber). The uterine glands are active during these months and probably furnish nourishment

for the sperms. This might also occur in P. kuhli.

In Zagreb, Yugoslavia, Dulić (1960) observed a female P. kuhli which flew into her room in December. It was kept at room temperature during the winter months and gave birth to two young on May 26. Assuming that fertilization does not take place until spring it is obvious that the sperms stored in the uterus had not lost their capacity for fertilization. In Egypt, Anderson and de Winton (1902) also found parturition occuring in May. Each female was reported to bear two young. Cheesman (1920a) stated that Buxton captured all pregnant females in Amara, Iraq during March. The means of parturition and length of gestation for P. k. kuhli have not been reported and could not be determined in such a limited study.

Even though there is a strong indication that sperms are retained all winter in the uterus and that fertilization takes place immediately following ovulation in the spring, this does not exclude two other possibilities. Ovulation and copulation could occur in the fall with fertilization following shortly as it does in the European bat Miniopterus schreibersi. The embryo might then suspend its development until the following spring. Mating could also occur again in the spring at the time of ovulation.

From observing captured specimens it seems likely that Pipistrellus kuhli reaches maturity after the second year. Juveniles are smaller and have a much darker pelage.

Cheesman (1920b) stated that in collections of pipistrelles, there was a large proportion of females to males. He mentioned that Buxton obtained one male to sixteen females in a series of P. kuhli in Amara, Iraq. In the Natural History Museum of this University there seems to be no discrepency in the sex ratio of P. kuhli kuhli. In a collection of

60 specimens there were 33 males and 27 females.

P. kuhli is generally gregarious although some have been reported living in small groups or singly in cracks and crevices of walls, brick houses and other cavities. On consecutive nights in November, 1960, the author observed 96, 95, 76 and 41 specimens leaving a hole in the roof of the Mann Building in Beirut. Before leaving the bats would make high pitched sounds. These were followed by a short silence and then a few bats would dart from the hole. From graph I on page 27. it may be seen that Kuhl's bats issued from their exit at distinct intervals. The groups were alternately large and small. It took about 20-30 minutes for the colony to leave. The apparent decrease in the colony was probably caused by the persistence of the owner who at the time was trying to exterminate the bats. Note in Fig. 2, page 24. that their guano had destroyed a portion of his plaster ceiling. Fairly large colonies were discovered in Barja and in Halba, Lebanon.

Small groups of 3-4 bats were noticed issuing from openings under the window sills of an apartment directly south of the Mann Building.

Anderson and de Winton (1902) refer to La Taste who reported only a single specimen in a crack of a stone fort in Algeria. More recently, Hatt (1959) observed a single specimen in a crevice of a wall in Baghdad, Iraq.

The white bordered pipistrelle has been known to live either close by or with other kinds of bats. Kahmann (1960b) collected a single specimen from a cavity under a stone on a slope of a small volcano on the island Volcano (Eolian Islands, Italy). In a similar position, he discovered P. savii. Chanudet (1950) captured P. kuhli living together with P. pipistrellus and P. nathusii in the Pavillon of Monfrault in

southern France. According to Harrison (1955) a small number of Kuhl's bats were discovered in the water falai tunnel in the Buraimi Oasis, Southeastern Arabia. Here they were observed to occupy an area apart from that used by Asellia and Triaenops. Apparently this association with other forms existed because all needed the protection and humidity of the tunnel against the desert heat. The author has not found any other bats living in Pipistrellus kuhli colonies.

When insects are scarce P. kuhli seems to stake out definite feeding territories and prevents other bats from remaining in the area. During the winter months (1960) the author noticed only one bat feeding in the orchard observation post. Any intruders were quickly chased away, seemingly warned by angry squeaks. Apparently it was not a mating response since at this time copulation does not as a rule occur. In addition, the chase ended abruptly at the end of the feeding territory.

Pipistrellus kuhli does not appear to enter complete hibernation during the winter months. During this period, except on very cold evenings and during rain, they may be found feeding in Beirut. Still their numbers are greatly reduced during the feeding time if compared to the summer months. Apparently they go into a stuper on very cold days but may be easily awaken if the temperature rises. The author kept two of them in the refrigerator over night. The next day, they were removed to room temperature and in about 5 minutes became active.

Harrison (1956) stated that the activity of P. kuhli was reduced during the winter months in Iraq and that they appeared in numbers only during the warmer evenings. Weber (1955) estimates that a succession of nights with a temperature of 3-5° C. and a maximum in the range of 17.8° - 20° C. are sufficient to induce some degree of torpidity.

In 1955, Weber reported that the tick Argas fischeri occurred on Pipistrellus kuhli in Iraq. Bodenheimer (1935) has identified the bedbug Cacodemus villosus from specimens collected in the Jordan Valley. He speculates that from this species the human bedbug Cimex lectularius may have evolved. Bedbugs from kuhl 's bats in Lebanon have been identified as Cacodemus tunetanus (Horvath) by R.L. Usinger of the University of California, Berkley. The Nycterbiids and the mites collected during this study await the attention of specialists. The only siphonapteran collected thus far has been Ischnopsyllus consimilis (Wahlgren) of which Pipistrellus kuhli is the true host.

There is considerable color variation in Pipistrellus kuhli. Bourlière (1955) states that in southern Europe its coat is dark brown, almost black. In the hilly maritime region of Algeria its pelage becomes a bluish green with the membranes much diluted in color. Finally, in the northern Sahara the bat is yellowish or whitish gray with the membranes cream colored or grayish. Harrison (1960) observed a geographical cline from Cyprus, Palestine, Northern Iraq, Central Iraq and Oman. He concluded that "not only does the pelage become more pallid from northwest to southwest, but also the wing border gradually widens and then invades the whole wing membrane, producing finally the very pallid, reticulated membrane of P. kuhli ikhwanius". In Lebanon, I have observed a wide range of coloration from silvery tan to dark brown. (Plate IV., fig. / ,p.26.). In Beirut alone there were four different specimens which ranged from dark beige to a dark brown, pictured in (plate IV., fig. 2., p.26.).

Harrison (1959) observed the Black kite Milvus migrans migrans (Boddaert) attack a Pipistrellus kuhli in Iraq. He has speculated that

the pallid color of these bats might serve as camouflage against predatory birds.

The corrected mean and standard deviation were determined from 60 external and 30 cranial measurements of P. k. kuhli captured in Lebanon. The external calculations were compared with specimens taken from southern Europe in the collection of the Senchkenberg Museum at Frankfurt, Germany. This comparison shows that the European specimens are somewhat larger in size, particularly in tail and ear length. As yet, Dr. Felton of the Senchkenberg Museum has not sent the cranial measurements of the European collections.

V. Conclusion:

From the literature cited and the author's observations, it can be concluded that P. k. kuhli commonly inhabits various cavities in old buildings, throughout the Republic of Lebanon. It seems to prefer altitudes at sea level. This is probably associated with generally warmer temperatures and a higher humidity near the Mediterranean Sea. This bat was observed at a maximum altitude of 1450 meters in Ehden.

Kuhl's bats exhibit two distinct flight patterns. Their crusing flight is straight and very high usually in the direction of some feeding area. While feeding, they tend to fly low and erratically. This flight is usually much slower than their crusing speed.

The feeding period begins at dusk, lasting about 15 to 35 minutes in winter and extending up to an hour in summer. During the summer, these bats usually feed in groups along water courses or in open fields. In winter, when insects are scarce, it was noted that only one bat fed in a confined territory. Any other bats that tried to invade the area were quickly chased out. Many bats were observed capturing insects near lights. In the stomach contents, the remains of insects were almost impossible to identify. Related works, state that these bats apparently prefer dipterans and lepidopterans as food.

Copulation probably occurs during the months of September and October. Whether this process is completed during flight or in the roost has not been reported. Apparently the sperms are stored in the uterus during the winter months. They might derive nurishment from the uterine glands. Ovulation might occur in the spring with fertilization soon following. It has been reported that two young are born at a time. This occurs in the month of May. It seems likely that

P. kuhli reach maturity after the second year. Juveniles are much smaller and have a darker pelage.

These specimens are generally gregarious, although some have been found living in small groups or singly in cracks and crevices of various habitats. It was observed that a colony of Kuhl's bats left their exit hole in a definite distribution pattern. At the start, their numbers were small, but later they increased considerably, until most of the colony had left. Then a few strays flew out to complete the exodus. Also the numbers in a group issuing from the exit seemed to alternate from few to many.

Pipistrellus kuhli does not appear to enter complete hibernation during the winter months. During very cold days or in rain, it was not observed.

The ectoparasites reported on Kuhl's bats are; the tick, Argas fischeri, the bedbugs, Cacodemus villosus and Cacodemus tunetanus and the flea, Ischnopsyllus consimilis.

The white bordered pipistrelle has a considerable color variation both in the world and in Lebanon. This bat exhibits a geographical cline, becoming more pallid from northwest to southwest. In Lebanon, the bat ranged from a silvery tan to a dark brown.

It was discovered that the European species are slightly larger than those of Lebanon, especially in their tail and ear lengths.

TABLE I

MEAN AVERAGE AND STANDARD DEVIATION OF MEASUREMENTS OF
Pipistrellus kuhli

A. American University of Beirut Museum of Natural History

1. Cranial

	Area Measured	Corrected Mean	Standard Deviation	Predicted Standard Deviation
a.	Greatest length	13.4	0.942	0.280
b.	Condylo-basal L.	12.9	0.260	0.260
c.	Zygomatic Breadth	7.74	0.387	0.30
d.	Breadth of Braincase	6.6	0.10	0.28
e.	Inter-orbital Constr.	3.42	0.06	0.22
f.	Max. teeth (c-m)	4.78	0.05	0.18
g.	Man. teeth (c-m)	5.43	0.250	0.30
h.	Mandible length	9.70	0.246	0.22

2. External

	Area Measured	Corrected Mean	Standard Deviation	Predicted Standard Deviation
a.	Total length	82.4	4.20	3.80
b.	Tail length	37.1	3.30	3.00
c.	Hind Foot length	6.3	0.576	0.40
d.	Ear length	12.0	1.37	1.30
e.	Tragus length	6.0	1.20	0.90
f.	Forearm length	34.9	1.20	1.50

B. Senchkenberg Museum Frankfurt, Mammal Section

1. External

	Area Measured	Corrected Mean	Standard Deviation	Predicted Standard Deviation
a.	Total length	82.65	3.74	2.90
b.	Tail length	38.17	1.62	1.70
c.	Hind foot length	-.-	-.-	-.-
d.	Ear length	13.0	0.794	0.90
e.	Tragus length	5.9	0.770	0.70
f.	Forearm length	34.5	1.05	1.10

TABLE II

External Measurements of *Pipistrellus k. kuhli* from the American University of Beirut Museum of Natural History

Key: f = female, m = male.

No.	locality	Total length	tail	hind foot	ear	tragus	forearm
A.U.B. Campus, Beirut							
S-6039	m	81	35	5	11	6	33
S-6040	f	80	34	6	10	4	34
V-5950	m	74	30	7	12.5	7.5	34
V-5951	f	80	35	7	11	7	37
V-5952	f	77	30	7	12.5	7.5	35
V-5946	m	81	36	7	13	7	33
S-6027	f	86	35	6	11	4	35
S-6083	m	73	30	5	10	6	33
V-5937	m	82	36	7	13.5	7	33
V-5931	m	87	38	7	15	7.5	34
V-5944	f	83	36	7	13	7	34
V-5943	m	85	35	7	13.5	8	36
V-5936	m	82	36	7	13	7	33.5
V-5933	m	84	37	6.5	15	7.5	34
V-5942	m	78	35	7	13	7	33.5
V-5941	f	84	36	7	13	7	35
V-5934	f	82	38	6.5	14	7.5	36
V-5939	f	84	36	7	13.5	7	35
V-5959	m	78	35	7	13	7	34
S-6073	m	77	37	5	11	6	34
S-6076	f	88	43	7	12	4	34
S-6077	f	86	38	7	11	4	35
S-6070	f	80	38	6	11	6	35
S-6072	m	85	38	6	11	6	35
S-6038	f	87	35	5	11	5	35
S-6037	m	72	32	7	10	4	32
S-6058	m	79	36	5.5	10	6	33
S-6041	f	84	37	6	11	4	35
S-6036	f	85	40	6	12	4	35
S-6066	m	83	37	6	12	6	33
S-6057	m	84	40	6	11	5	34
S-6042	f	86	35	6	12	4	36
S-6026	f	82	32	6	10	4	34
V-5932	m	86	40	7	14.5	7.5	36
V-5935	m	76	38	7	14	7	33
V-5938	f	82	34	7	13	7	34
V-5940	f	86	38	7	13	7.5	34
S-6086	m	90	42	6	11	6	36
S-6090	m	81	35	7	11	6	36
S-6091	f	81	36	6	12	5	34
S-6061	f	83	40	6	11	6	35

TABLE II

External Measurements of *Pipistrellus k. kuhli* from the American University of Beirut Museum of Natural History

Key: f = female, m = male.

No.	locality	Total length	tail	hind foot	ear	tragus	forearm
Ras Beirut							
S-6081	m	76	36	6	10	5.5	39
S-6082	m	74	34	6	11	6	34
Barja,							
S-6043	m	83	39	6	11	5	34
S-6044	m	84	40	6	11	4	35
S-6045	m	90	40	6	10	4	37
S-6053	f	83	34	6	10	6	35
S-6055	m	81	40	6	11	4	35
S-6054	m	84	40	6	13	5	35
S-6056	f	87	41	6	11	5.5	36
S-6048	f	80	40	6	10	5.5	33
S-6049	m	86	41	7	12.5	6	35
S-6050	m	86	42	7	14	7	35
S-6051	f	84	41	7	13	7	35
S-6052	m	83	40	6	10.5	4	35
S-6059	m	83	35	5	11	4	35
Tyr,							
S-6087	f	84	40	6	11	5.5	35
S-6088	m	90.5	45	6	12	6	35
S-6089	f	89	42	6	11	5	35
Antelias,							
S-6080	f	75	35	5.5	9	6	34

TABLE III

Cranial Measurements of *Pipistrellus kuhli kuhli* from the American University of Beirut Museum of Natural History

Key: f = female, m = male.

Number	Greatest Length	Condylo-Basal Length	Zygomatic Breadth	Breadth of Brain case	Constr. teeth c-m	teeth c-m	Mandible
S-6078 f	13.5	13.0	7.7	6.6	3.5	4.9	5.2	9.5
S-6079 m	13.5	12.9	7.0	6.6	3.4	5.0	5.6	9.9
S-6026 f	13.3	12.7	7.9	6.9	3.3	4.9	5.4	9.7
S-6075 m	13.9	13.2	7.3	6.5	3.5	5.1	5.6	10.2
S-6086 m	13.4	12.9	7.4	6.3	3.4	4.9	5.4	9.6
S-6087 m	13.5	13.0	7.6	7.0	3.4	5.0	5.5	10.0
S-6089 f	13.4	12.9	7.6	6.4	3.4	4.9	5.8	10.1
S-6088 m	13.7	13.0	7.7	6.5	3.5	4.9	5.3	9.7
S-6076 f	13.7	13.2	7.9	6.8	3.6	4.9	5.5	9.6
S-6073 m	13.2	12.6	7.1	6.3	3.3	4.8	5.2	9.5
S-6072 m	13.6	13.0	7.8	6.5	3.5	4.9	5.1	9.6
S-6077 f	13.5	13.0	8.5	6.8	3.7	4.8	5.3	9.7
S-6052 m	13.2	12.9	7.7	6.7	3.5	5.0	5.7	9.4
V-5933 m	13.3	12.8	7.2	6.5	3.5	5.1	5.5	10.0
S-6048 f	13.0	12.3	7.4	6.4	3.5	4.9	5.2	9.4
S-6053 f	13.3	12.9	8.3	6.6	3.5	4.7	5.3	9.6
V-5936 m	13.3	13.0	7.8	6.4	3.6	4.8	6.4	9.9
S-6050 m	13.7	12.8	7.5	7.0	2.7	5.1	5.5	9.7
S-6041 f	13.0	12.5	7.3	6.5	3.3	4.9	5.4	9.7
S-6049 m	13.1	12.7	7.4	7.7	3.5	5.1	5.5	10.2
V-5942 m	12.7	12.4	7.7	6.3	3.4	4.8	5.1	9.6
S-6055 m	13.3	12.9	8.2	6.8	3.4	5.0	5.5	9.2
V-5941 f	13.1	12.6	8.3	6.5	3.4	4.7	5.4	9.5
V-5939 f	13.6	13.2	8.1	7.0	3.7	5.0	5.3	9.9
S-6045 m	13.9	13.5	8.3	6.3	3.5	5.3	5.5	9.9
S-6042 f	13.1	12.9	7.8	6.4	3.1	4.5	5.3	9.7
S-6056 f	13.5	12.9	8.0	6.6	3.5	5.0	5.4	10.0
S-6047 f	13.0	12.6	7.7	6.3	3.4	5.0	5.4	9.9
S-6058 m	13.4	12.6	7.5	6.6	3.4	4.9	5.0	9.6
S-6044 f	13.4	12.8	8.1	6.3	3.7	5.2	5.5	9.8

TABLE III

Cranial Measurements of Pipistrellus kuhli kuhli from the American University of Beirut Museum of Natural History

Key: f = female, m = male.

Number	Greatest Length	Condylo-Basal Length	Zygomatic Breadth	Breadth of Brain case	Constr.	teeth c-m	teeth c-m	Mandible
S-6078 f	13.5	13.0	7.7	6.6	3.5	4.9	5.2	9.5
S-6079 m	13.5	12.9	7.0	6.6	3.4	5.0	5.6	9.9
S-6026 f	13.3	12.7	7.9	6.9	3.3	4.9	5.4	9.7
S-6075 m	13.9	13.2	7.3	6.5	3.5	5.1	5.6	10.2
S-6086 m	13.4	12.9	7.4	6.3	3.4	4.9	5.4	9.6
S-6087 m	13.5	13.0	7.6	7.0	3.4	5.0	5.5	10.0
S-6089 f	13.4	12.9	7.6	6.4	3.4	4.9	5.8	10.1
S-6088 m	13.7	13.0	7.7	6.5	3.5	4.9	5.3	9.7
S-6076 f	13.7	13.2	7.9	6.8	3.6	4.9	5.5	9.6
S-6073 m	13.2	12.6	7.1	6.3	3.3	4.8	5.2	9.5
S-6072 m	13.6	13.0	7.8	6.5	3.5	4.9	5.1	9.6
S-6077 f	13.5	13.0	8.5	6.8	3.7	4.8	5.3	9.7
S-6052 m	13.2	12.9	7.7	6.7	3.5	5.0	5.7	9.4
V-5933 m	13.3	12.8	7.2	6.5	3.5	5.1	5.5	10.0
S-6048 f	13.0	12.3	7.4	6.4	3.5	4.9	5.2	9.4
S-6053 f	13.3	12.9	8.3	6.6	3.5	4.7	5.3	9.6
V-5936 m	13.3	13.0	7.8	6.4	3.6	4.8	6.4	9.9
S-6050 m	13.7	12.8	7.5	7.0	2.7	5.1	5.5	9.7
S-6041 f	13.0	12.5	7.3	6.5	3.3	4.9	5.4	9.7
S-6049 m	13.1	12.7	7.4	7.7	3.5	5.1	5.5	10.2
V-5942 m	12.7	12.4	7.7	6.3	3.4	4.8	5.1	9.6
S-6055 m	13.3	12.9	8.2	6.8	3.4	5.0	5.5	9.2
V-5941 f	13.1	12.6	8.3	6.5	3.4	4.7	5.4	9.5
V-5939 f	13.6	13.2	8.1	7.0	3.7	5.0	5.3	9.9
S-6045 m	13.9	13.5	8.3	6.3	3.5	5.3	5.5	9.9
S-6042 f	13.1	12.9	7.8	6.4	3.1	4.5	5.3	9.7
S-6056 f	13.5	12.9	8.0	6.6	3.5	5.0	5.4	10.0
S-6047 f	13.0	12.6	7.7	6.3	3.4	5.0	5.4	9.9
S-6058 m	13.4	12.6	7.5	6.6	3.4	4.9	5.0	9.6
S-6044 f	13.4	12.8	8.1	6.3	3.7	5.2	5.5	9.8

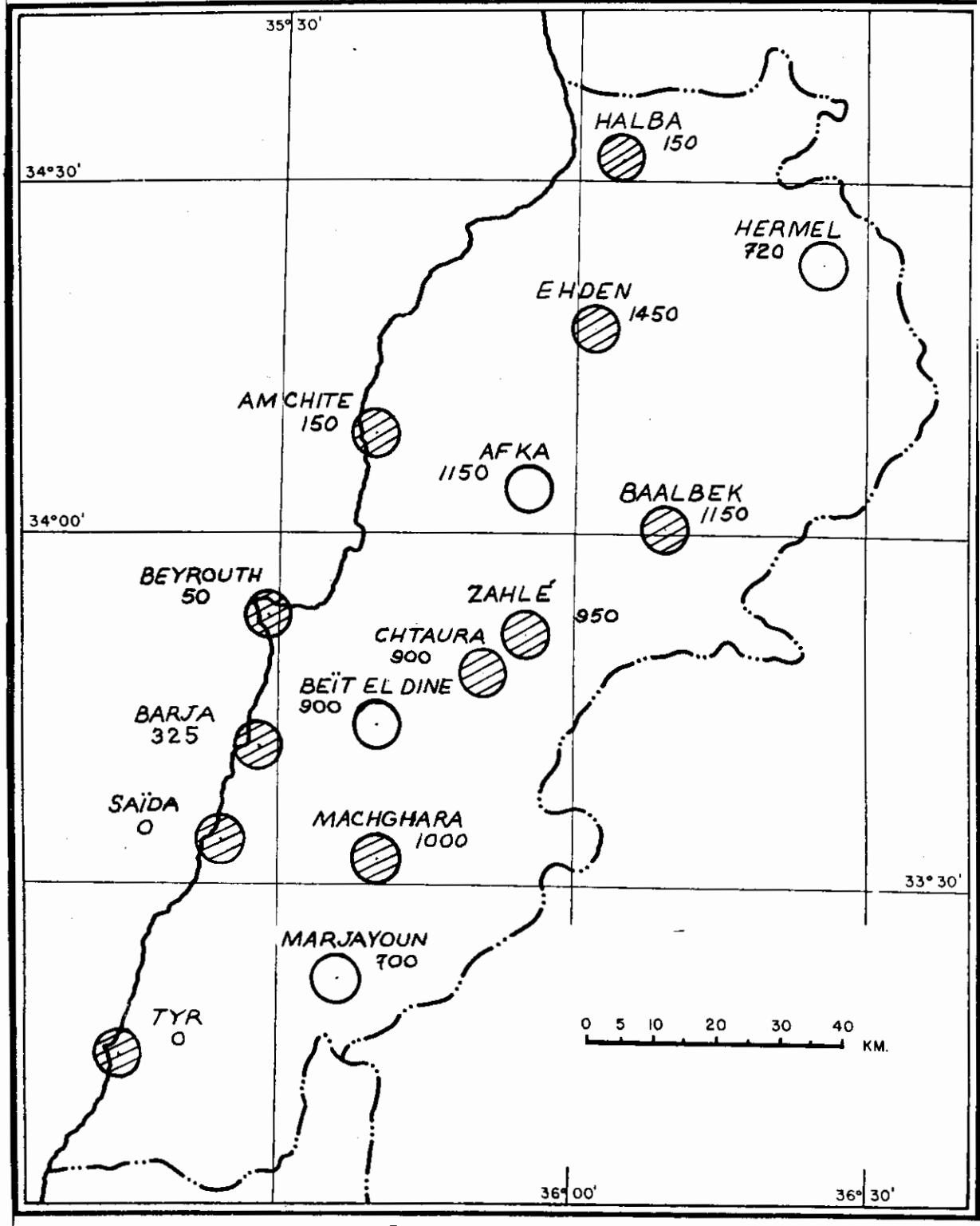
TABLE IV

External Measurements of Pipistrellus kuhli from the Senchkenberg Museum Frankfurt, Mammal Section

Key: (SMF-No. = Senchkenberg Museum Frankfurt)
f = female, m = male.

SMF-No., locality	Total Length	tail	hind foot	ear	tragus	forearm
Sierra de Carrascoy, S.E. Spain						
18 688 f	86	39	6	12	5	34.5
Sierra de Cazorla SE-Spain						
18 689 m	84	39	6	13	5	35.5
18 690 m	83	38	6	14	7	34.0
18 691 f	88	39	7	13	6	36.0
18 692 f	85	38	6	14	6.5	34.0
18 693 f	88	40	6	13	6.5	35
18 694 f	84	39	6	13	6	35
18 704 f	89	39	6	13	6.5	35.5
18 705 f	88	39	6	13	7	36
Sicily						
12 720 m	84	39	6.5	12	-	35
16 990 m	83	39		13	6.5	33
16 992 m	83	39		12	5	35
16 993 m	89	42		12	5	34
16 994 m	84	39		13	5	34
16 995 f	81	37		13	6	34
16 996 f	76	35		12	6	34.5
16 997 f	79	37		12	6	35
16 998 f	87	39		15	5	35
16 999 f	82	38		12.5	6	34
17 000 f	81	37		13	6	33.5
17 001 f	83	38		13	6	35.5
17 002 f	81	37		12.5	4	33.5
17 003 f	78	37		13	6	34
17 004 f	80	37		12	6	35
17 010 m	79	37		13	5	34
17 011 m	80	36		12	6	33
17 012 m	75	34		13	4.5	31.5
17 013 m	82	38		13	5	34
17 014 m	77	36		12	6	33
South, France						
15 198 m	80	35		11.5	4	33.5

MAP 1



DISTRIBUTION OF *PIPISTRELLUS KUHLI KUHLI* IN LEBANON

KEY

CIRCLE INDICATES SELECTED STATION WITH ALTITUDE IN METERS

HATCHED CIRCLE REPRESENTS EVIDENCE OF *P. K. KUHLI*

PLATE I.

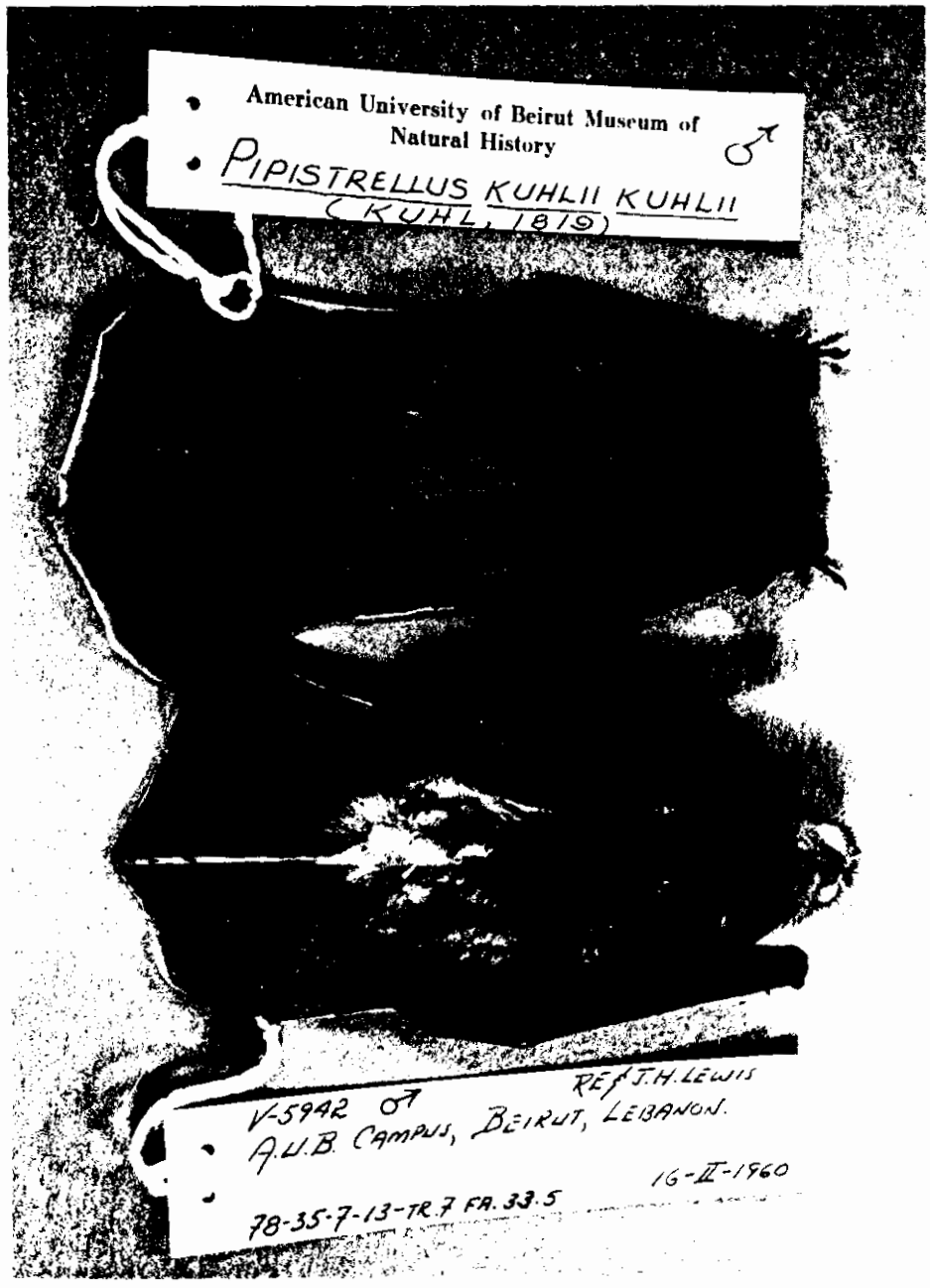


FIG. I. PIPISTRELLUS KUHLI KUHLI FROM LEBANON.

PLATE II.

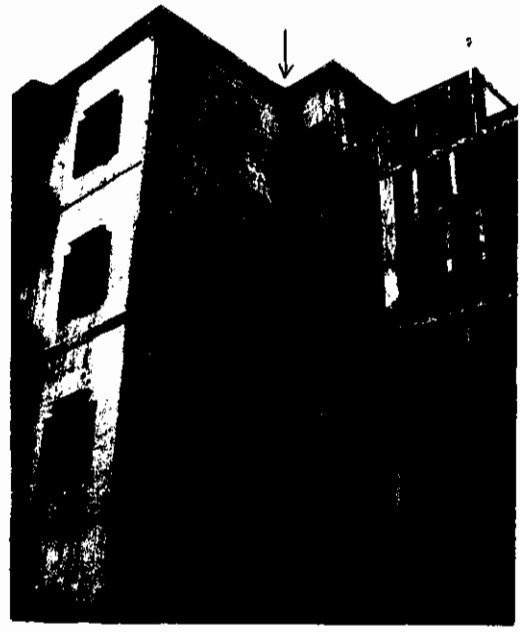


FIG. 1. ARROW INDICATES THE EXIT HOLE.
(MANN BUILDING, BEIRUT)

FIG. 2. DESTRUCTION OF PLASTER CEILING
CAUSED BY COLONY. (MANN BUILDING)

PLATE III.

FIG. 1. ARROWS POINT TO CREVICES FILLED WITH KUHL'S BATS. NOTE GUANO DEPOSITS NEAR ENTRANCE. (CHURCH MEETING HOUSE, HALBA)

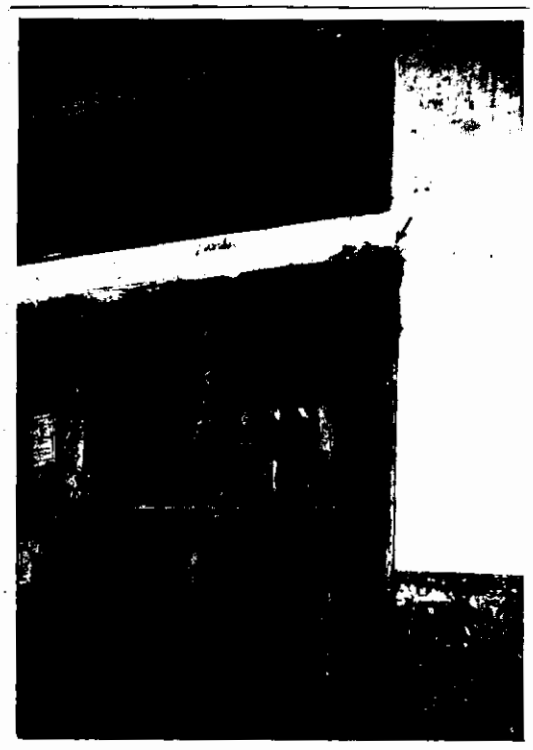


FIG. 2. CLOSE UP VIEW OF FIG. 1.

PLATE IV.

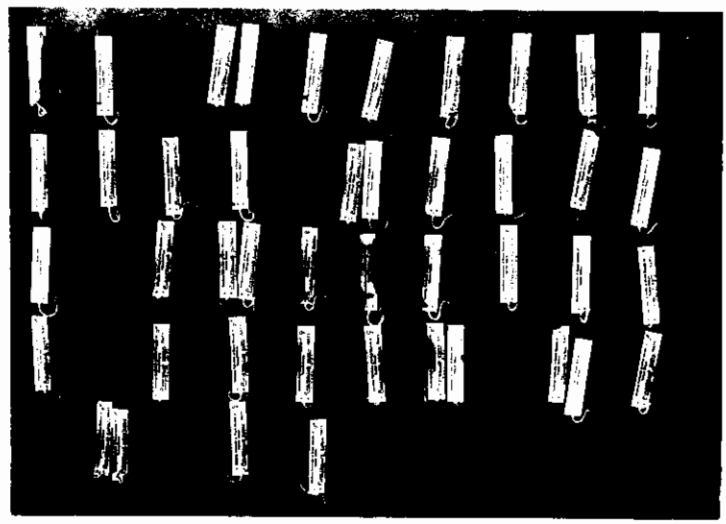


FIG. 1. COLOR VARIATION EXHIBITED IN A RANDOM ASSORTMENT OF JUVENVILES AND ADULTS CAPTURED IN LEBANON.

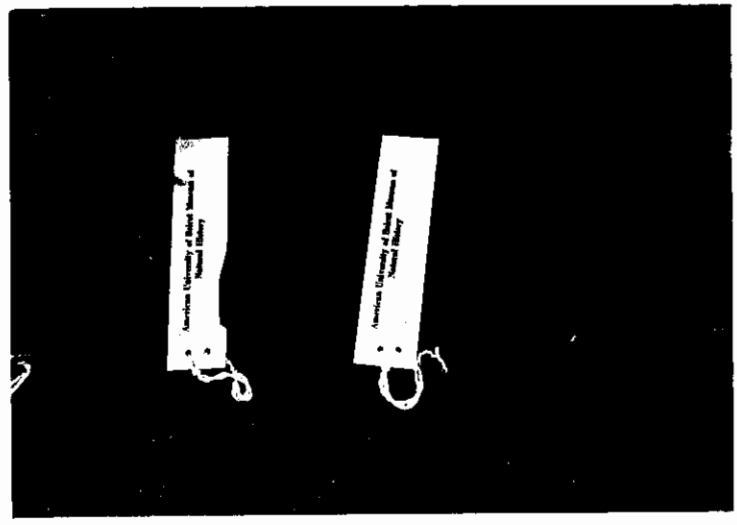
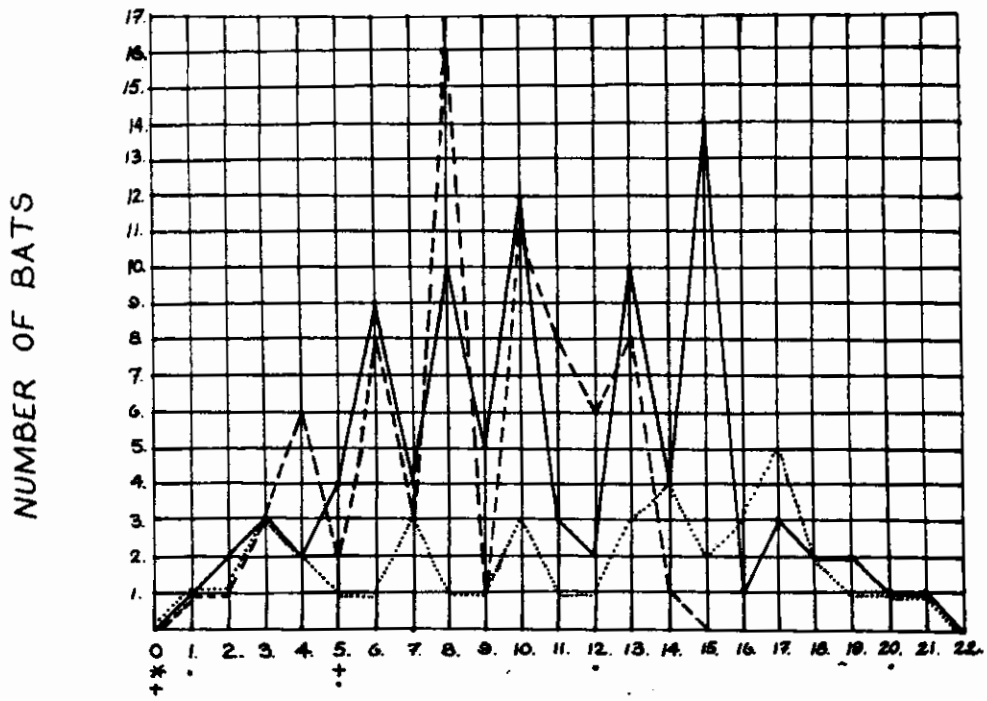


FIG. 2. VARIABLE PELAGES IN A SERIES OF KUHL'S BATS OBTAINED IN BEIRUT.

GRAPH I.

THE DISTRIBUTION OF EXIT INTERVALS OF A COLONY OF *PIPISTRELLUS KUHLI* MANN BUILDING, BEIRUT



KEY: *, +, • = NOISE

COLONY	NO. OF BATS	DATE	EXIT TIME
—— A_1^*	95	6-XI-60'	4:40 P.M. - 5:17 P.M.
----A_2^+	75	7-XI-60'	4:50 P.M. - 5:19 P.M.
·····$A_3^•$	41	8-XI-60'	4:48 P.M. - 5:20 P.M.

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