- PN-ABT-373

FINAL REPORT

ON THE PROJECT," BIOLOGY ECONOMIC IMPORTANCE OF WILD BAOR IN PUNJAB

BY

DR. MUHAMMAD HAFEEZ KHAN
PRINCIPAL INVESTIGATOR
ASSOCIATE PROFESSOR
DEPARTMENT OF ENTOMOLOGY
UNIVERSITY OF AGRICULTURE
F A I S A L A B A D

1990

Project financed by United State Agency for International Development Mission to Pakistan, Under food Security Management.

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Name of the Project	: Biology and Economic Importance of Wild boar in Punjab (Pakistan).
Name of the P. I.	: Dr. Muhammad Hafeez Khan.
Project No.	: 0491-C 004/87 (I).
Date of initiation	: March, 1987.
Duaration of the Project	: 3½ years.
Report period	: Final report.
Total allocation	: $ 36,000/- (Rs. 6,12,000/-).
Amount received	:
Amount spent upto 30.6.90	: $ 36,000/- (Rs. 6,12,000/-).

Project financed by United States Agency for international Develoomen Mission to Pakistan, under Food Security Management.

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FIELD EVALUATION OF BLOOD ANTICOAGULANT AND ACUTE POISONS FOR THE CONTROL OF WILD BAOR.

by.
Muhammad Hafeez Khan

ABSTRACT

The efficacy of 2 blood anticoagulants, warfarin and rocumin and five acute poisons C1080 (sodium monofloro acetate) Temik 10G & 100, Dimecron 100 (phosphomidon), Furadan 35 ST and Arsenic trioxide were evaluated for the control of wild baor, Sus scrofa, in a series of experiments. C1080 gave amazingly good results. Temik and Dimecron proved faily good where as Furadan and Arsenic trioxide did not prove very effective. In case of blood anticoagulants both warfrin and rodumin proved very effective for wild boar control.

INTRODUCTION

Wild boar, Sus scrofa, is an important pest of crops both in barani (rainfed) and irrigated crop lands in Pakistan, Beg and Khan (1982), Brooks et al. (1989), Smiet et al. (1979) from the farmers point of view they are nearly impossible vertebrate pest to dealwith. They are willy and smart and are large and strong. They can injure or kill humans when they are frightened or attacked. They are very difficult to keep out of food croos. Farmers feel difficulty in irrigating their fields specially sugarcane croo fields during the night hours and the wild baors do not allow any person to enter the fields. The farmers have no really good method to protect their crops from damage. Among lethal methods of control used in the past, shooting remains an expensive method and few farmers possess shotguns. So most attention has been paid to methods of poisoning using highly toxic insecticides like aldicarb(Temik) Khan et al. (1980) or extremely toxic redenticides, used as fluro-acetamide and sodium fluroacetate (Shafi and Khokhar, 1986). These

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materials, while no dount, extremely effective when used by professionals, are not suitable for use by the farmers and may be hazardous for the livestock and wildlife in the area poisoned. Therefore five old and new acute poisons were tried with new substrates for wild baor control. To avoid shyness development against the poisons used substrates were changed after each baiting.

Experiments were also conducted for searching alternate toxicants where shyness is not developed and are not hazardous to livestock and wild life in area poisoned. For this purpose anticoagulant materials were considered for use, several of which have been shown to be quite toxic to domestic and feral pigs (Dobson, 1973, Hone and Kleba, 1984) warfarin appears to have good potential as a pig poison (Hone and Mulbgan, 1982). Several studies have shown that warfarin is highly toxic to pigs, a chronic LD_{50} of 0.05mg/kg over 7 days (Back, 1978), chronic oral LD_{50} of 0.4mg/kg over 5 days (Crisoon et al. 1975) and Worthing (1979), a lethal dose of 1 mg/kg over 5 days.

Likewise Dobson (1973) indicated that conmatetralyl at dosages ranging from 0.1 to 1.0 mg/kg created hemorrhage in 8 pigs, 3 of which survived the lowest dosages because of vitamin-K therapy. All the others died 8th day from consuming 0.25 to 1.0 mg/kg of conmatetralyl for 7 days. He concluded that a total intake of less than 2 mg/kg should be lethal provided this is given over a period of 7 days. Rotenone, the plant extract from Derris elliptica and other Derris sop. was suggested by Matschke (personal comm.) as a candidate acute toxicant for wild baor.

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According to a report by Kingscote et al. (1951) rotenone is toxic to pigs.

The evaluation of these acute and anticoagulant toxicants and different baits are discussed in the present report.

METHODS

The study area for the trials of acute poisons was located in Tehsil Jaranwala, District Faisalabad, Dala Nangul, District, Sheikhupura, Chak No. 33/J.B., Tehsil Faisalabad. and for blood anticoagulants poisons Salarwala Forest, Chak No.155 /G.B.,Tehsil Faisalabad was selected and warfarin technical grade was used. For conducting experiments on coumatetralyl a second blood anti-coagulant poison Probynabad Army Stud Farm on Depalpur, Pakpattan Road, District, Okara was selected. Salarwala Forest Chak No. 155 is situated in central Punjab lying about 30 km from Faisalabad city, is an area of acacia (Acacia modesta) and mesquite (Prosopis juliflorea) forest or scrubs, intermixed with stands of march grasses (Saccharum munja) in low lying area. The forested area is bounded by irrigation canals on three sides and crop fields on the the fourth. The entire forested area is surrounded by crop lands in the opposite sides of cansl. In this area control experiments for the efficacy of warfarin were conducted.

Brobynabad Army Stud Farm where experiment for evaluation efficacy of coumatetralyl for wild boar control was conducted is situated on Depalpur Pakpattan Road about 15 km from Depalpur. This farm is mainly reserved for agricultural crops. Wild boar

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control experiment was conducted in a block of 265 acres of sugarcane crop.

TOXICANTS

Temik 10% granules were supplied by Union Carbide U.S.A. This toxicant was used in the boiled maize bait. Temik 10G was treated in the laboratory and 100% Aldicarb was prepared for use in the field against wild baors.

C 1080 (Sodium monofluro acetate) was used in small capsules containing 30-60 mg. C1080 in each. This method of encapsulation was used to avoid sub-lethal dose to be taken by any wild boar in any case.

Phosphomidon available in the liquid form was absorbed in bran or gram flour. This material was dried in the shade and filled in gilatin capsules of 500 mg.

Arsenic trioxide was used in guava fruits by boring into the fruits and filling the hole with ½ tea spoonfull of poison and the hole was covered over with the pulp. This experiment was conducted at P.A.F. base, Faisalabad.

Furadan 35ST which is supplied by FMC in liquid form was absorbed in grain flour and filled in 500 mg capsules. Blood anticoagulants were used with wheat grains in the following ratio:

Warfarin Bait:	Warfarin (technical grade)	1 gm.
	Gur(Brown sugar)	800 gm.
	Ghee	200 gm.
	Wheat	19 Kg.

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In case of rocumin the material was used in the following ratio:

Wheat	9 Kg.
Gur(Brown sugar)	400 gm.
Oil	100 gm.
Rocumin(0.75%)	500 gm.

BAITS

In case of Temik 10G boiled maize was used as substrate and brown sugar and full cream dry milk as attractant to the poison. In case of Temik 100 material was filled in capsules and such capsules were put in the field in weaned flour balls of squash ball size. Same method was used for poison bait of C1080 Furadan 35 ST and Phosphamidon. Arsenic trioxide was used in guava fruits.

Blood anticoagulants were used with wheat grain, brown sugar and oil was used as binder and a attractant.

WOODEN HOG FEEDERS

Wheat grain baits were placed in wooden hog feeders 60 x 60 cm sq. with four slanting wooden doors on the top. These were sited in an area of heavy wild baor activity used as a resting or hiding areas. Each hog feeder was filled with 10 to 20kg of bait. The area around each hog feeder was smoothed daily to check animal visits from foot prints. Baits were replenished as needed. Baiting continued until wild baor visits stopped.

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TRIALS OF DIFFERENT CHEMICALS FOR THE CONTROL OF WILD BOAR

Wild pigs are of agriculture concern in Pakistan because of their current impact on agriculture like crop damage, loss to human lives and dissemination of diseases such as leptospirosis and sparganosis. Wild pigs are of considerable concern also for their potential role as a reservior of infection of several exotic diseases such as foot and mouth diseases, etc. The main method of controlling wild pigs damage are poisoning, trapping, shooting, fencing, habitat changes & changes in agricultural management. The short term effectiveness of the control method is usually assessed by the percentage kill and the prediction of its long term effects are based on knowledge of the remaining populations, expected rate of increase, etc.

Different chemical methods were used to control wild boar during this year. The details of these methods are described here.

A. FURADON 35 ST

The wild pig population was estimated by route count method consecutively for three days and then poison baiting was done and wild pig population was also estimated the same way after poisoning.

Materials and Methods

Liquid poison was absorbed in gram flour and material was dried in the shade. The material was filled in 500 mg gelatin capsules. These capsules were dipped in low melting point wax to mask the odour. These capsules were used in weaned flour balls coated with attracting material i.e. full cream dry milk, powder of cyprus and in some cases only coating of gram flour. This poison was used at Riaz Model Farm of Chak No. 33/J.B., District Faisalabad. Total number of animals in 10 acres of sugarcane crop were estimated to be 11-12 (Table 1).

Table 1. Mortality to wild boar when using Furadon at Riaz Model Farm

Date	No. of animals before baiting	No. of balls put	P. balls consumed	Dead animals seen or reported	Population after baiting
17.1.88	12	20	16	-	-
20.1.88	-	-	-	1	-
24.1.88	-	-	-	-	-

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Total elimination of the wild boar was reported by the farmer. After poison baiting no animal was observed in cultivated fields and no damage was observed to any crop. Poison has given good control. These results shall be further confimred next year.

B. ARSENIC TRIOXIDE

Arsenic trioxide is odourless and tasteless poison. This poison was used in guava fruits by boring into the fruit and filling the hole with 1/2 teaspoon full of the poison. The hole was covered over with the pulp of the fruit. Prebaiting of guava fruits was done for three days.

After three days prebaiting, 100 guava fruits filled in with 1/2 teaspoon of Arsenic trioxide were put at PAF Base Faisalabad. Response to the unpoisoned guava fruits was 60% during the prebaiting days When the poisoned guava were put response was only 26%. No dead animal was observed even upto 15 days of poison baiting. At the Air Base there is about 6 acres area which was very thick. This area was cleaned in 1988. During cleaning of sarkanda and weeds officer commander of the base reported that many old skeletons of the animals were observed. The bones of animals were collected and burried in the soil. This trial shall be repeated again to confirm the results and to see the effectiveness of this poison to wild pigs.

C. ALDICARB

Materials and Methods

A first experiment was carried out at the forest of Chak No. 155/R.B. In this forest there is a mixed plantation of both wild and planted trees. This jungle comprises of about 500 acres. Due to thick wild mesquite and sarkanda plantation it has become a permanent breeding place of the wild pigs. Work on the control of wild boars was started on 13.9.1987. The population estimated in that forest was between 120 to 150 animals. The first baiting was done with Temik 10 g by using boiled maize as substrate and full cream dry milk as attractant. Farmers of the village Chak No. 155 Panwan arranged prebaiting for 5 days and 5 bait stations were set and out of that animals were attracted to only two stations. On 18.9.1987 poison baiting with 10 kg maize 200 gm Temik and 500 gm full cream dry milk was put at each of two bait stations. Animals consumed 8 kg bait from one station and 1.5 kg from the other bait station. The remaining bait was burried deep in soil to avoid any hazard to human beings and domestic animals. The results of this trial are given in Table 2.

Due to thick plantations, it was very difficult to trace out the dead bodies. But when the number of animals were counted again by route count method it ranged from 40-50. When farmers were contacted they reported some relief from these animals.

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Table 2. Effect of Temik on the Mortality of Wild Pigs at Chak No. 155

Date	Estimated No. of wild boar	Wt. of baiting material	Estimated No. of animals survived	Bait consumed	No. of dead wild boar traced or reported	No. of other animal species dead
18.9.87	120-150	20 kg		9.5 kg	2	3 porcupine 21 rats 10 squirrels
19.9.87		-		-	3	3 porcupine
20.9.87		-		-	1	-
21.9.87		-	40-50	-	-	-
Total					6	6 porcupine 21 rats 10 squirrels

A second experiment was conducted at village Dalanangal District Sheikhupura in a block of sugarcane comprising 25 acres and at Latif Model Farm near Jaranwala in a block of 40 acres of sugarcane fields.

The Aldicarb 10 g was used with boiled maize as substrate. In the second case Aldicarb was dissolved in Acetone and solution was filtered. The filterate was dried over a water bath to get 100% material. The 100% material was used in Gelatin capsules of 100-150 mg.

At Umar Draz Agricultural Farm at Village Dalanangal which comprised 25 acres of sugarcane crop, poison baiting with Temik 10 g with boiled maize was done at the animal's tracks. Heaps of one kg boiled maize were placed at animal's tracks which were covered over with 15-20 gm of Temik 10 g, 50 gm full cream dry milk and 5 gm powder of cyprus roots. Poison baiting was done in the evening at animals tracks and next morning left over poison bait was weighed to see the reponse of the animals to the bait. Only three animals were found dead as a result of first baiting (Table 3).

Third experiment was conducted at Dala Nangal using Temik 100% filled in Gelatin capsules of 150 mg. Each capsule was put in weaned flour balls of squash ball size which were covered over with full cream dry milk and powder of cyprus roots.

A counted number of these balls were put on the wild boar tracks and next morning balls were again counted to evaluate the response of the animals to poison balls. Results are given in Table 4.

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Table 3: Results of Boiled Maize Poison Bait

Date	No. of animals in square block before poisoning	No. of bait heaps	Bait Consumed	No. of dead animals
3.10.1987	27	10 heaps of one kg each (10 kg)	2.4 kg (from 3 spots)	-
4.10.1987	-	-	-	2
5.10.1987	-	-	-	1 dead animal traced
6.10.1987	-	-	-	1 dead animal was reported
7.10.1987	-	-	-	Population was counted to be 19 after baiting

Table 4. Effect of Temik 100% on the Mortality of Wild Pigs

Date	Estimated No. of wild pigs in sugarcane block	No. of poison balls put	No. of Balls consumed	No. of Dead animals traced or reported
28.11.1987	24	50	46	-
29.11.1987	-	-	2	4
30.11.1987	-	-	-	1
08.12.1987	-	-	-	11
14.12.1987	-	-	-	7
			Total	23

Fourth experiment was conducted again at Dala Nangal District Sheikhupura. Animals were coming to eat the scum at cane crushing machine which was being used in making brown sugar and gur.

The spot was visited on 21.1.1988 and from the tracks of the animals it was estimated that a group of 9 animals were visiting this spot regularly. On 22.1.1988 evening 50 gm of Temik 10 g was mixed with scum in a 1 x 3 ft pit near the crushing machine, the wild pigs visited the spot and entire scum (about 6 kg) was consumed by them. On 23.1.1988 search for the dead bodies was started but we were unable to trace any dead wild boar by 9.2.1988. Farmers of adjoining square reported that some bad

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smell was coming from the nearby fields. Next morning daily paid labourers were enaged and all the fields were searched out. Nine dead bodies (entire group) were found within a radius of about 10 meters. This method gave 100% mortality of the wild pigs. Two dogs were also reported killed by taking poisoned scum.

D. DIMECRON 100 (PHOSPHEMIDON)

Phosphomidon, an organo-phosphate (Dimecron) is easily available in the market and its mammalian toxicity is 26 mg/kg wt. This poison is safe to use as compared to other poisons like C 1080 and Temik, which are being used in the field for the control of wild boars.

Dimecron 100 was absorbed in equal quantity of bran or gram flour. This material was dried in shade for 2-3 days and then filled in gelatin capsules of 500 mg and dipped in low melting point paraffin wax to mask the taste and smell of the poison. Three to 4 capsules were put in weaned flour balls with a coating of attracting materials as used in other cases. This poison was also used as such with boiled maize and attracting material.

Chakku Forest comprises of 700 acres with mixed plantations of shesham, mesquite, pines, paper mulberry, etc. This forest is well irrigated from Upper Chenab Canal from one side and from its distributories from other side.

Wild pig population was counted by examining the animals tracks in Kukarwala Block comprising 115 acres and poison baiting was done on 7.3.1988. Total 100 flour balls containing 2000 mg toxic material in each ball was put near the resting places of the animals and on the tracks leading to the water sources. The results are given in Table 5.

Table 5. Effect of Dimecron on Wild Boar

Date	Estimated population	No. of poison ball put	No. of poison balls consumed	Dead bodies seen or reported	Population after baiting
7.3.88	25-30	100	21	0	-
8.3.88	-	-	2	1	-
9.3.88	-	-	-	-	-
10.3.88	-	-	-	-	8

Dimecron was used in Chakku Forest, Kukarwala. 100 poison balls were placed at the animals tracks on 7.3.1988. Out of which 21 balls were consumed and on 2nd day i.e. 8.3.1988 two more poison balls were consumed by the wild pigs. Only two animals were found paralysed which later on died about 55 and 70 meters from the place of baiting and the third animal was found dead about 180 meter from the place of baiting. The observation of the first day was that the animals were paralysed, unable to

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move any body part except eye lids which were working normally. Over secretion of saliva was noted from the mouth of both the animals. These animals died after about 1 1/2 hours of locating them.

Only three animals were found dead but there was 71% reduction in the population of wild pigs in the forest. These animals either had died and were not traced out or escaped due to some other reasons.

The poison can very easily be used by the farmers with good results.

E. EFFICACY OF C 1080

About 1 1/2 months after the Temik baiting farmers again reported presence of animals and damage to their crops in the Chak No. 155 area. Second baiting was started on 5.11.1987. This time capsules of C 1080 containing 60 mg poison and 100 mg of plasil (an antivomiting agent) were used. The observations recorded are given in Table 6.

Table 6. Effect of C 1080 on the Mortality of Wild Pigs

Date	No. of poison balls placed	No. of balls consumed	No. of Dead Wild pigs traced or reported	No. of other animals died
5.11.87	200	106	2	1 porcupine 1 jungle cat
6.11.87	50	11	1	3 porcupine
7.11.87	-	-	-	1 porcupine
8.11.87	-	-	-	5 porcupine 1 jungle cat
Total	250	117	3	10 porcupine 2 jungle cat

After baiting number of animals were again counted by the same method. The total estimated population was 10-15 wild boars. Since then this jungle has been searched out many times with dogs and beaters but the population observed was very low, and no damage to growing crops around the jungle was reported by the farmers. On 23.2.88 the farmers were again contacted and a complete relief was reported. Later on, population was counted and tracks of only 11 animals were observed in the whole jungle.

A second experiment was conducted at Latif Model Farm near Jaranwala, District Faisalabad and Chak No. 48/M.B., District Khushab. C 1080 poison was filled in gelatin capsules of 60 mg with 100 mg of plasil. Each capsule was placed in a weaned flour ball. The flour balls were coated with full cream dry milk, powder of cyprus and before placing in the animals track each

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ball was sprinkled over with female sex pheromine diluted 100 times in skimmed milk.

Another experiment was conducted at Chak No. 48 M.B., District Khushab. In a jungle of mixed plantation, the number of animals were counted to be between 30-35 from the tracks. The soil around the jungle was hard and grassy, therefore, exact number of the animals could not be counted from the foot prints. Routs of the animals were traced out which were nine (9) in number and flour balls containing poison capsule and coated with attracting materials were placed at the routes on 25.10.1987 Only 17 poison balls were consumed first day as the animals came out of the jungle from only three routes. On 26.10.1987 more poison balls (30) were put on the same routes. These were also consumed by the wild baors. Only one dead body was seen in a nearby field and no other dead body was traced out due to inaccessable condition of the jungle. On 28.10.87 the routes of the animals were again examined and tracks of only 3-5 animals were observed.

Presence of wild baors was reported at Latif Model Farm Tehsil Jaranwala, in a block of 40 acres of sugarcane. It was estimated from the tracks that there were about 20-25 animals in the block. 100 weaned flour balls containing c1080 capsules (60mg) in it were put at the animal tracks on 27.11.1987. Out of those 100 balls, 41 balls were consumed by the animals the same night. Only three dead bodies were traced out from the water channels of the 40 acres block of sugarcane. On 10.3.88, the land lord after cutting the sugarcane croo, reported that there

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was large scale mortality as skeletons of many animals were seen during the harvest of the crop.

EFFICACY OF ROCUMIN AS WILD BAOR TOXICANT

Blood anticoagulant baiting trial was conducted at Probynabad Army Stud Farm. This farm is situated on Depalour Pakoattan Road, in District Okara. A block of sugarcane which comprised of 265 acres was selected for conducting experiment. For evaluating the wild baor population 12 spots were selected for setting bait stations after thoroughly observing the routes of the wild baors. At each baiting station 10 kg wheat was put in open hog feeding boxes and next day activity of the wild baor visiting the spot was observed and number of wild boars was estimated by counting the animal tracks. The quantity of the wheat grains consumed from the boxes was made up by adding more wheat in the boxes. This activity continued for 10 days and daily observations were recorded. At 12 baiting stations set, animals visited only 4 baiting stations regularly. The total number of the wild baors visiting these baiting stations estimated to be between 35-40. The experiment was started on 5.9.1990 and the first observation was recorded on 6th and the last on 15.9.1990. The experiment was started on 17.9.1990 and baiting boxes were put at 4 successful baiting stations which showed wild baor activity. Each hog feeding box contained 10 kg baiting material with the follwoing formula:

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Wheat grains	9kg
Shakkar	400 gm
Ghee	100 gm
Rocumin (0.75%)	500 gm

Hog feeding boxes were put on 17.9.1990 at 4 selected baiting stations. From 17.9.1990 to 20.9.1990 animals did not try to open the boxes. After 20.9.1990 the wild baors started feeding and two boxes were opened on 21.9.1990. Third on 22.9.90 and the 4th on 24.9.1990. The first two boxes were removed from the baiting station on 26.9.1990, 3rd on 28.9.1990 and the 4th on 29.9.1990 each after 5 days of feeding. After 29th the wild boar activity was very much reduced. Blood spots were also observed at places where wild baor trials were observed. No dead wild baor was observed. Sugarcane crops bumper and it was extremely difficult to search out the entire block. After removing the boxes wild baor activity was again evaluated and it was estimated that the number of animals was not more than 6 to 7 in the field. It was also assumed by examining animal tracks that the surviving animals were aged and were weighing over 50 kg.

Experiments on the effectiveness of rocumin as wild baor control toxicant was again repeated on the same farm (Probynabad Army Stud Farm). This time no prebaiting was done. Wild boar population was estimated by observing the animal tracks in the water channals and by smoothing the passage of permanent routes of the animals.for five days. On 10.10.1990 population was estimated to be 12-15. This population was that which came out of the block from west side of sugarcane fields. 5 hog feeders were put at 5 spots

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routes of the wild boars. Each hog feeder contained 20 kg prepared bait with open top. Wheat grains were trailed towards the hog feeder to bring the animals close to the baiting stations. Wild boars started feeding bait the very first day but rate of consumption was low. The quantity of the bait was replanished daily. Average bait consumption increased with the passage of time and on sixth day it was maximum i.e. 7 kg per box. After that rate of bait consumption declined and blood spots were also observed on one box. On 17.10.1990 the hog feeders were removed from the baiting station. One dead body of wild baor weighing about 75 kg was seen on 18.10.1990 in a water channel. From 20.10.1990 to 25.10.1990 activity of wild baors was again observed. Tracks of only three animals were observed, possibly new commers to that sugarcane block. Rocumin is very effective for wild baor control. But farmers are not convinced to use this poison due to its disadvantage of multidose baiting.

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DISCUSSION

The acute poisons used during the series of the experiments proved very successful for the control of wild boars. Specially C1080 gave amazingly good results. In the use of this poison two difficulties were faced.

1. Animals vomited spreading poisoned grains in the area around the baiting spots and as a result non target species were effected. To over come this difficulty 100 mg plasil an antivomiting material was used along with the poisoned capsules with good results.

2. In case of repeated baiting shyness is developed in the wild pigs to over come this difficulty substrate of the baiting was changed every time for example if wheat grain balls were used in the first baiting boiled maize was used in the subsequent baiting with this method. This difficulty was partially solved.

In case of this TRIAL Temik proved to be the second best poison and proved a cheap control technique to the farmers. In case of Aldicarb there was quick knockdoen of the animals and the farmers were encouraged by observing the dead bodies of the wild boar next day in the baiting area. In this case again difficulty of shyness was faced which was covered partially by changing the substrate of the bait. Scum (Molasses) proved to be the best substrate for baiting with any poison.

Furadan 35St, Phosphomidan and Arsenic trioxide also proved successful for the control of wild baor out of these three poisons, Furadan 35ST and Phosphomidon were equally good and arsenic trioxide proved to be least effective as compared to all the poisons

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tried.

The use of anticoagulant bait materials to control wild baor populations gave very satisfactory results. Wild baor resoonsed to anticoagulant baits in a oattern similar to that of domestic rats. The bait sites must first be located by the animals. Then bait consumotion increase daily until a peak is reached. Any where from the 5th to 8th day. Bait consumption then declines rapidly as the animals become affected and start dying. The great advantage of anticoagulants baits over acute toxicants that they apparantly do not create a bait shyness nor do the animals vomit the baits, as they are known to do when ooisoned with sodium monofluro acetate (O' Brien et al. 1986) and presumably floro acetamide.

The major disadvantages of anticoagulants are:

1. They are slow to act, meanwhile crop damage continues and farmers become impatient.
2. They require a very large amout of baits when ooisoning wild baor (a) large boar can easily eat 5 kg of bait at one time.
3. They are attractive to and kill nontarget animals, especially porcupines, jackals and dogs.

To over come this difficulty, modified hog feeders were provided by the team leader, Mr. Joe E. Brooks, which were used in the field and completely excluded porcupines and jackals from the baiting cycle. Modified hog feeding boxes, baited with anti-coagulant baits may offer promise in poisoning wild baor in olaces where they could be permanently and securely installed. In forest

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plantations and at air bases which are chronically infested with wild baors. At these situations hog feeders can be utilized with advantage.

Maize and wheat grains can be used as bait substrate ~~for~~ crude brown sugar (shakkar) and molasses (gur) are good attractant for wild baor.

CONCLUSION

Sodium monofluro acetate (C1080) was much effective for wild baor control. Temik, phosphomidon and Furadan 35ST were fairly good for wild boar control. Arsenic trioxide did not prove very effective. Baiting substrate needs change after every baiting to avoid shyness against bait in wild baor population. Anticoagulants are extremely promising for wild baor control, inspite of its disadvantage of multidose use to be effective.

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ECTOPARASITES OF WILD BAOR

ABSTRACT

519 wild baors were killed by gun shooting during the project period. Three species of ticks; Rhipicephalus sanguineus (Latereilli, 1806), Boophilus annulatus and Boophilus microplus and one species of louse, Haemotopinus suis Linn, were collected from them and identified. One species each of ticks and lice were sent to British Museum for identification.

INTRODUCTION

Ectoparasites such as lice, mites, ticks and warbles, of pig and livestock are very important but they have not attracted the proper attention of the researchers of this country. The ectoparasites are known to cause tremendous economic losses in livestock industry in this country due to their usual habit of blood sucking causing irritation, annoyance and in some cases even their migration in the body tissue of the larval stages, such as those of Hypoderma in various internal organs of the body. Ultimately appearing in the body surface particularly in the back of the animals by burrowing through the skin and falling on the ground.

In case of blood sucking ectoparasites the vector suffer from blood loss and anaemia of varying intensity depending on the number of ectoparasites infesting an animals and their nutrition. Because of blood loss animal keep poor physical condition, especially when younger animals are victimised they exhibit stunted growth, low resistance of infectious diseases and a times they may even succumb if infestation is very heavy. Some blood sucking ectoparasites are known to secrete substances which are toxic to the host,

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hence death may take place due to toxicity such as tick paraylsis.

All these numerous competitors, the lice and ticks are among man's worst enemies. They are all parasitic and many of them transmit diseases to man and animals. Ticks convey piroplasms and parasitic worms, virus and bacteria, anaplams, sprichetes, rickettsis and paralytic toxins, lice is responsible for carrying epidemic typhus, brill's disease and murine typhus fever. Trench fever and many other diseases, Kaiser and Hoogstraal (1964) made an extensive survey of Pakistan, India and Cylon and recorded three subgenra Hyalommasta, Hyalommina and Hyalomma with nine species, Chaudhry, (1965) reported the occurrence of only two species from West Pakistan viz., Boophillus microplus and B. annulatus that parasitized cattle, buffaloes and sheep in this country. Sharif (1928) mentioned only two species of the genus Rhipicephalus, Kosar (1965) reported only one species of Rhipicephalus viz., Rhipicephalus sanguineus.

MATERIALS AND METHODS

For the collection of ectoparasities wild baors were killed by gun shooting and ectoparasites were collected by hand picking. In case of ticks little heat was given to the ticks before picking with a cigarettes so that they loosen their bite. The collected specimens were preserved in 5% formaline solution and stored for later study. For the study of the structure of different parts such as capitulum, legs, spiracles etc. microscopic preparations were made as under.

Ticks & Lice brought from the field for identification were boiled

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in 10% sodium hydro-oxide solution for half an hour during which time they became clear from the sttached debris, hair etc. The specimens were then treated with 10% acetic acid (CH_3COOH) for about 30 minutes to remove the traces of alkali. They were then washed and stained with acid fuchsin for about 30 seconds and washed again to remove the excess of stain. The soecimens were then passaged through 30%, 50%, 75%, 90% and absolute alcohol for dehydration by keeping them for 15 minutes in each dilution. The specimens were then transferred to clove oil or cedar wood oil and kept over night. They were then dipped in xylene and mounted in canada balsam and examined.

For identification of the species keys prepared by Nagar, (1963); Sharif (1928); and Kaiser and Hoogstraal (1964) were followed throughout the course of this investigation.

RESULTS

Prepared slides of the ticks and lice were examined under the microscope and the best slides which showed all the characters of the specimens were selected for detailed studies.

TICKS:

Characters of the specimen slides were observed and compared with available keys. Three tick species were identified and one species showed characters which were not comparable with any available key. As soon as the keys are available or information is is received from London, detailed report about above species shall be published.

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DESCRIPTION

Boophilus microplus:

Very short, compressed palpi, redged dorsally and laterally, Bases capituli to hexagonal dorsally. Eyes present Inornate, Festoons absent, Spiracular plate rounded. Male with adanal and accessory adanal shields. Anal groove obsolete in female. Faint in male. Caudal process present or absent.

Female with internal and external spurs of coxa I broadly rounded and wider than long Coxa IV with or without very small external spur.

Male with caudal process at posterior extrimity of body.

Collection Materials:

56/G.B. (Faisalabad) ♂ 1 ♀ 3, 11.05.1990
23/G.B. (Faisalabad) ♂ 2 ♀ 4, 11.05.1990
61/G.B. (Faisalabad) ♂ 2 ♀ 4, 03.05.1990

Host:

Wild boar (Sus scrofa)

Habitat: of Host. Sugarcane.

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Boophilus annulatus

The body of Boophilus annulatus was approximately rounded in shape, but slightly tapering towards the anterior side. The festoon were not present on the posterior margin of the body. The body of the unfed tick was balloon shaped. The body of these ticks was inornate and without white marking on the dorsal sheild. The capitulum was present at the anterior end of the body which was visible from above and below. The sides of the basis capituli was laterally produced and was distinctly angulated. Capitulum was short in relation to width. The second palpal segment was not especially longer than width. Second palpal segment was not actually laterally produced at the base. The palpi were with acute transverse ridges dorsally and laterally.

The scutum or dorsal sheild was present which was short in females and long in males. The eyes were present on the sides of the scutum. Fore coxa was not deeply cleft. The anal groove was distinct. The males were with normal legs.

Collection Materials:

Air base (Faisalabad)	♂ 5 ♀ 8	, 31.v.1988
61/G.B. (Faisalabad)	♂ 2 ♀ 5	, 3.V.1990
Chatha Chak(Toba Tek Singh).	♂ 2 ♀ 3	, 9.VI.1988

Host:

Wild boar (Sus scrofa)

Habitat of host: Mesquite, Sarkanda.

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Rhipicephalus sanguineus (Latreille, 1806)

The body of the Rhioicephalus sanguineus was broader at the spiracles and became narrower gradually toward the anterior sides. Body is 3.5 to 4.5 mm in length. The festoons were distinct on the posterior margin of the body. The body of unfed male was pyriform.

The basis capituli was hexagonal when viewed from dorsal aspect and broader than long. The posterior three sides of the basis capituli were concave. The hypostome was spatulate in outline and divided into two similar halves by a longitudenal fissure. The distal portion was smooth and proximal portion was provided with six files of teeth.

The scutum covered the whole of the dorsal surface of the body. The surface of the scutum was smooth and without any hair. It was elongated, narrowed anteriorly and with semicircular posterior margin.

Legs were found successively larger from anterior to posterior end. Coxa I was deeply divided in two ports forming external and internal spurs.

The spiracular plates were situated a little behind the last pair of the legs on the lateral margins of the body.

Collection Materials:

Air Base (Faisalabad) ♂ 2 ♀ 3 , 11.I.1989
Kangan (Faisalabad) ♂ 1 ♀ 2 , 7.I.1989
Chak 79/G.B(Faisalabd) ♂ 2 ♀ 3 , 1.VI.1990.

Host: Wild baor (Sus scrofa)

Habitat of Host:

Sugarcane , Mesquite.

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Unidentified Tick specimen:

The body was approximately rounded in shape like that of Boophilus sp. It was slightly narrowing towards the anterior side. Body was inornate, it was not provided with festoons. When the specimen was infed ti looks like semifilled balloon. The basis capitulum was hexagonal when viewed from dorsal aspect and broader than long. The posterior sides of the basis capituli were concave but antero-lateral side were almost straight. The palpi were twice as long as broad. The scutum covered nearly the half of the dorsal surface of the scutum was smooth and with out any hairs. Legs were found normal and approximately of equal size and length. Coxa I was deeply divided in two parts forming the external and internal spurs. The spiracle plates were situated a little behind the last pair of the legs on the lateral margin of the body. The spiracles were concave in shape.

Collection Materials:

Air Base (Faisalabad) 2 ♂ 3 ♀ , 10.I.1990

Host:

Wild baor , Sus scrofa.

Habitat of host:

Mesquite.

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Haemotopinus suis (Linn.)

Large sized species, 4-6 mm in body length; ectoparasite of wild baor, Sus scrofa.

Head 2-3 times longer than broad, produced in front of antennal and deeply inserted into the thorax, provided with small bristles. Eyes absent, but with prominent ocular lobes posterior to the antennae. Antennae 5-segmented, provided with small setae near apex of each segment, all segments similar.

Thorax broader than long, segments strongly fused with each other; spiracles on dorsum present; a pair of small setae on each segment. Legs with tarsus 1-segmented, a lobe like pretarsal sclerite on the distal surface of the tibia present; 2nd pairs of claws serrated on inner margin segments provided with small setae.

Abdominal negments distinct, with paratergites prominent forming strong lobes but apical margin of plates not free from body, labial setae small, not reaching the next fergite, each abdominal tergite with a median pair of setae and two pairs of laternal setae; spiracles on each paratergite present.

Male genetalia without discernible parameters, female with well-developed gonapods on 8th abdominal segment.

Collection Materials:

III-G.B. (Faisalabad), 2 ♂ 3 ♀ , 18.V.1990

Khechian(T. T. Singh), 1 ♂ 5 ♀ , 20.VI.1990.

26/G.B. (Faisalabad), 3 ♂ 2 ♀ , 29.VI.1990.

Host: Wild baor, Sus scrofa

Habitat of host: Mesquite plantation.

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THE LOUSE (unidentified specimen)

The body of the specimen was tapering towards both ends, i.e., narrower gradually toward the anterior as well as posterior sides. The abdomen at the middle was broader in width. Head was composed of two prominent ocular points instead of eyes. These ocular points were commonly found posterior to the antennae. The head was deeply inserted into the thorax. The sternal plate of the thorax was completely absent in the presence of ocular points which is a confusing character. The body of the specimen was not thickly beset with setae or scales. The abdominal plates were present.

Collection Materials:

Air Base (Faisalabad)	10♂ 4♀,	11.VI.1990
Chak No.11 (Faisalabad) G/B.	3♂ 2♀,	15.VI.1990

Host:

Wild boar *Sus scrofa*.

Habitat of host:

Sugarcane and Sarkanda.

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DISCUSSION

Very meager informations on the ectoparasites of the wild baor is available in Pakistan. The tick species which have been identified from Pakistani wild baor are: Rhipicephalus sanguineus (Latereilli, 1806), Boophilus annulatus and Boophilus microplus. These species have already been described and all these parasitised cattle especially buffaloes. Since skin of buffaloes and wild baor is very similar. Therefore, this is natural that parasites are also of the same type. One species collected appears to be a new one. Characters have been described and for identification the specimen has been sent abroad. Two species of lice have been collected one is identified as, Haemotopinus suis Linn. which is very common in areas where wild baor is found. The second has also been described and appears to be a new record. This has been sent abroad for identification. No other parasite has been observed on the wild baors which have been collected during the project period.

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ENDOPARASITES OF WILD BAOR

ABSTRACT

Faces in the ilium and rectum portions of the intestine of 164 wild baors, Sus scrofa , were examined in the lab. Infection of, Fasicoloosis burbi was found 10.9%, Metastrongylus apri 9.1%; Metastrongylus westermani, 8.5% , Coccidia spp. 11.5%, Ascaris lumbricoides 7.9%, Ascaris vitulorum 10.9%, Ascaris strangylina 4.9%, Bourgelatia deducta 3.6%, Ascarops strongylina 3.6% and Necator spp. 3.0%. Whereas 25.5% samples were found negative.

INTRODUCTION

Wild baor (Sus scrofa) is of great agricultural importance in Pakistan and is found up to 1000 m elevation in up land areas of the country and at lower elevations through out Punjab. Parts of the North West Frontier Province, and in Sind to the mouth of the Indus River (Robents, 1977). In all the provinces of Pakistan being an agriculture country cattle farming and sheep and goat farming is practiced on a larger scale. Farmers are adapting various precautionary measures to protect their animals from the infection of various endo-parasites like, Coccidiosis (Chapman, H. D., 1974) which in sheep is characterised by Hoemorrhagic diarrhae,dipression weakness, loss of weight (Jenson & Singh, 1982) and infection of Coccidiosis has been identified in pigs collected from Faisalabad area. Similarly (Humbert, J. F. and C. Henry, 1989) detected five species of lung nematodes Metastrongylus asymmetricus, M. confusus, M. elongatus, M. pudendotictus and M. Salmi and two species of stomach nematodes Ascarops strongylinia and physocephalus sexalatus were found in Sus scrofa in France and these species also cause health complications in sheep, goat and buffaloes, Guret, 1931.

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Similarly Ascaris vitulorum has been detected from wild baor and the same has also been detected from young calves and buffaloes in Philippine by Molintas, (1938).

Helminths, Arthropods and protozoa of domesticated animals has been studied by Soulsburg, (1982) which cause anaemia, general malaise and diarrhae in cattle and some of these has also been identified from the intestines of the wild baor. Therefore, need was felt to study the endoparasites of wild baor. The work done during the project period is summarised as under:

MATERIALS AND METHODS

After killing an animals, the abdomen was opened in the field, desired pieces of intestine (ileum and rectum) were cut. Their either ends were knotted securely, without wasting the intestinal contents. These pieces were transferred to the jars containing 10% formaline, and marked jars were then transferred to the laboratory. In the laboratory each specimen was run through a variety of processes to rule out the probability of missing any kind of eggs. First direct smear was examined. A drop of water was put on a glass slide, mixed with intestinal contents and was covered over by a cover slip. This slide was then examined under low power microscope.

Second method employed was the salt floatation technique. One part of sample mixed thoroughly with ten parts of saturated solution of sodium chloride were centrifuged and cover slip was carefully taken up from the tube with the drop attached under

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neath surface. It was placed on a clear glass slide, and slide then scanned under low power microscope for eggs.

Third process employed was zinc sulphate floatation technique for detecting fluke eggs. Here, I used saturated solution of zinc sulphate and processed in the similar way as the previous one was done.

RESULTS

During 1989-90 from 20.05.1989 to 05.08.1990, 164 samples were collected. It was actually 164 wild baors killed over a period of about 15 months. A variety of parasites were detected to be residing in the animal. These are briefly discussed as under:

Out of 164 animals killed 80 were males and 84 females. Out of all these samples 25.5% (42) were not carrying any infection 17% showed mixed infection and 5% species showed deformed eggs.

Following is the list of parasites which have been identified from the intestinal tract of wild boar.

1.	*Fasicoloosis burbi*	10.9% (18).
2.	*Metastrongylus apri*	09.1% (15).
3.	*Metastrongylus westermani*	08.5% (14).
4.	Coccidia sp.	11.5% (19).
5.	*Ascaris lumbricoides*	07.9% (13).
6.	*Ascaris vitulorum*	10.9% (18).
7.	*Ascaris* sp.	04.9% (08).
8.	*Bourgelatia deducta*	03.6% (06).
9.	*Ascarops strongylina*	03.6% (06).
10.	*Necator* sp.	03.0% (05).

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DISCUSSION

Wild baors mostly live togather in the jungles and move in groups ranging from 1-2 to 31, which have been observed during the project period. Therefore, the chances of inter baor transmission of parasitism were increased due to their congested living. This also contributes towards mixed infection as the incidence was seen in 17% samples. 25.6% (42) of the samples were found to be negative. A significant thing was that the sample collected from Khichian, District Jhung, were found mostly to be negative. Animals killed from dry places especially from sarkanda weeds were negative over 66%.

Young animals weighing upto 16 kg body weight did not carry any infection. This supports that significant impression of baby wild baors to be free of parasitism. Indicating the infection transmitted among wild baors Acariasis was detected in 22.7%(39) specimen animals, mostly killed around Air Base and chanchal Singh wala, Tehsil Faisalabad. But Paragominus westermanii was detected in animals of higher body weight. The infection of Bourgelatia deducta, Acarops strongylina and Necator sp. appeared to have made considerable effect on the general body grwoth and weight gain of wild baor. The incidence Fasciolopsis burbi 10.9% was seen in older animals mostly killed in sarkanda and mesquite plantation. In most of the cases animals were infected but still appeared to be healthy. In some animals deformed ova were also observed but this might be due to prolonged storage of the samples. All the animals were killed not far away from the villages and mostly around the fields of sugarcane, wheat, sarkanda and mesquite etc. where these animals

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roam about especially at night for it feed. These on one hand ruin the crops and on the other hand also paly a very effective role in transmitting the infections especially the parasitism.

The defication it does on crops and later on these crops are cut for feeding animals as so far no cooking is done for the cattle feed, so the infection is taken uo readily by cattle. Goat, sheep etc. or who so even fed. So the matter should be taken seriously and have to plan more effectively to eridicate the wild baor from our land in the interest of humanity and in the larger interest of the country.

CONCLUSION

Wild baor in Punjab is mostly carrying infections of various types and in some cases it is vector of cattle parasitism. Infection which have been detected from the gut of the wild baor can infect the cattle and farm labour which work in the fields and where wild baor feces is common. Therefore, the matter should be taken seriously and a detailed work should be done on these lines.

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REPRODUCTION IN EURASIAN WILD BOAR, *Sus scrofa*, IN CENTRAL PUNJAB, PAKISTAN.

by

Ejaz Ahmad[1], Joe E. Brooks[2], Iftikhar Hussain[3] and Mohammad Hafiz Khan[4].

Abstract:

Based on 519 Eurasian wild boar (*Sus scrofa*) collected from March 1987 to July 1990 in central Punjab, Pakistan, the male:female ratio was 45.7 : 54.3. The age composition consisted of 48% of the boars being <12 months, 29% 12 to 24 months, and 23% > 24 months of age. Males attained sexual maturity at the age of 5 to 7 months and females in 4 to 6 months. There was seasonality in the testes weights of males, and the ovarian weights in females. Pregnancies were seen mainly in February through May; a few were recorded in August and September. Forward-dating fetuses and back-dating young animals (<6 months) indicated that most animals were born during the months of April through September. Litter sizes based upon fetal counts averaged 5.65 ± 2.16, but the number of young per litter in females <12 months (4.93 ± 1.98) was less than in females older than 12 months (5.87 ± 2.18), but the difference was not significant. The high reproductive potential observed means the wild boar of the central Punjab croplands are capable of sustaining their numbers despite heavy predation by man. Large-scale population reduction at strategic times in the annual population cycle (May/June and October/December) may be the best way to reduce crop losses.

INTRODUCTION

The Eurasian wild boar (*Sus scrofa*) is a significant pest of agriculture in Pakistan (Roberts 1977, Shafi and Khokhar 1986, Brooks et al. 1989). It damages sugarcane, maize, wheat, rice, sorghum and potatoes, and can be a powerful constraint on the introduction of new cropping patterns.

There are few studies on the biology and population dynamics of Asian populations of wild boar, aside from Diong's (1973) in Malaysia and a preliminary study in southern Pakistan by Smiet et al. (1979). Information on reproduction, home range size, habitat

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1. Program Specialist, USAID Vertebrate Pest Control Project, NARC, Islamabad, Pakistan.
2. Wildlife Biologist, DWRC, USAID Vertebrate Pest Control Project, NARC, Islamabad, Pakistan.
3. Scientific Officer, Government of Pakistan Vertebrate Pest Control Laboratory, NARC, Islamabad, Pakistan.
4. Assistant Professor, Department of Entomology, University of Agriculture, Faisalabad, Pakistan.

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use patterns, and dietary preferences of wild boar is needed in order to design and implement proper management strategies to reduce crop damage. Accordingly, a cooperative study was undertaken with staff at the University of Agriculture, Faisalabad, on the biology, morphometrics, food habits, and range of movement of wild boar. The objectives of this part of the study were 1) to determine the age at puberty in both sexes, 2) to define seasonal changes in male and female breeding capacity, 3) to determine if there was seasonality in the breeding pattern, and 4) to determine the average litter size and productivity of wild boar females.

MATERIALS AND METHODS

Wild boar were shot in crop and non-crop areas in Faisalabad District and immediately adjacent areas in Shekhupura, T.T. Singh and Jhang districts in central Punjab (Fig. 1) between March 1987 and July 1990. The main crop habitats were sugarcane, wheat, and maize fields. Non-crop areas consisted of marshy areas supporting growths of *Saccharum* and *Typha* species and dry-growth thickets of mesquite (*Prosopis juliflora*), *Acacia modesta* and shisham (*Dalbergia sissoo*). Each animal was sexed, weighed, and measured. The left or right ramus of the lower jaw was removed, tagged, and preserved in 5% formalin. We determined their ages by tooth irruption patterns modified from Matschke (1967), and Diong (1973) and wear on the third molar (Barrett 1978). We took eye lens weights but these were not used in age determinations since we lacked known-age specimens.

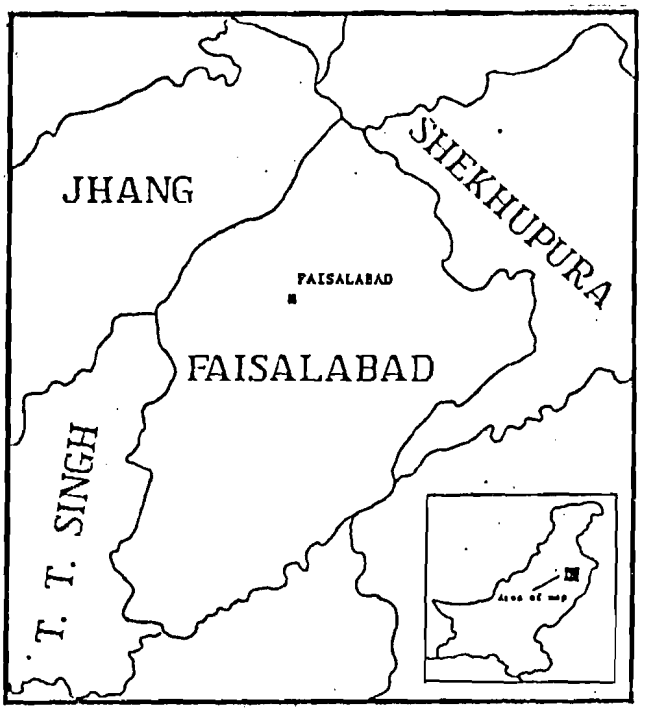

Fig. 1. Faisalabad and adjoining districts in Central Punjab

At necropsy, we collected both testis of males and preserved them in 5% formalin. Length, width, and weight were taken for each testis. The presence of visible tubules in the cauda epididymis was used as the criterion for puberty. The testis weight for each adult male wild boar was expressed as grams/kg body weight and plotted against each quarter of the year to determine if there were seasonal peaks in breeding activity of male boar.

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We removed the reproductive tract from each female boar and preserved it in 5% formalin. The observations we took during necropsy included: 1) presence or absence of corpora lutea, 2) teat numbers, and 3) number of fetuses in each uterine horn.

Fetuses, when present, were removed from the uteri and preserved in 5% formalin. Fetuses were counted, measured, sexed when possible, and aged (in days) according to crown-rump length (Henry 1968a). These data were used to calculate approximate dates of conception and parturition, using a gestation period of 115 days (Henry 1986b). Variation in litter size by age class was inspected, and the correlation of age and body weight of the females with the number of fetuses was tested.

Ovaries were weighed and then sectioned with a razor blade at 1.5 mm intervals and examined under a dissecting scope for follicles, corpora lutea, and corpora albicantia. Corpora lutea served as the criterion for determination of puberty. Back-dating ages of fetuses to determine the actual breeding age was also used to determine age of puberty for females.

Data on farrowing activity were collected by: 1) aging and forward-dating fetuses and 2) aging and back-dating young animals (<6 months old).

RESULTS

Sex and Age Structure

Five hundred and nineteen wild boar were collected, consisting of 237 males and 282 females, giving a male:female ratio of 45.7 to 54.3 . The age composition consisted of 47.6% of the wild boar up to 12 months, 28.7% aged 13 to 24 months, and 23.7% > 24 months (Table 1). The ratio of males to females increased with age.

Table 1. Age composition and sex ratio in wild boar collected from central Punjab.

Age (mos.)	Males	Females	Males/100 Females
Fetuses	84	83	101
0-4	29	28	104
5-8	63	90	70
9-12	10	14	71
13-24	66	75	88
25-36	32	35	91
> 36	26	25	104
Totals, Aged	226	267	84
Unknown age	11	15	
Totals	237	282	84

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Puberty

Both sexes come into breeding capability before they are one year old. We found a few males with visible tubules in the cauda epididymis as early as 4 to 5 months of age, but the onset of sexual maturity began at 6 months (over 50% of animals have visible tubules) and most males at 7 to 8 months were capable of breeding. Testis weights for several age groups are given in Table 2.

Table 2. Mean weight of testis (without epididymis) in male wild boar.

Age (mos.)	No. Examined	Testis Weight (g)±SD
4- 5	25	7.9 ± 7.9
6-12	39	51.0 ± 31.8
13-18	33	67.9 ± 27.6
19-24	23	127.3 ± 51.9
>24	51	161.6 ± 56.8

Females first began ovulating at 4 to 5 months (Table 3) and several were found pregnant at this age, indicating breeding even earlier. In the 1988 breeding season, 7 of the 30 pregnant animals were aged 6 to 12 months.

Table 3. Presence or absence of corpora lutea in young female wild boar.

Age in months	n	Corpora lutea present	
		Negative	Positive
0 - 2	8	8	0
2 - 4	4	4	0
4 - 5	10	5	5
5 - 6	10	2	8
6 - 7	12	0	12

Breeding Season

Mating activity, obtained by back-dating fetuses, began in different times each breeding season. It began in late December 1987 and continued into early March 1988 for the first season. The second breeding season began the very end of October 1988 and continued into early March 1989. The third breeding season began the first week of January 1990 and continued into the first week of April.

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Pregnant animals were seen in February through June and in September 1988, in January through May and August and September 1989, and in February through June 1990 (Fig. 2).

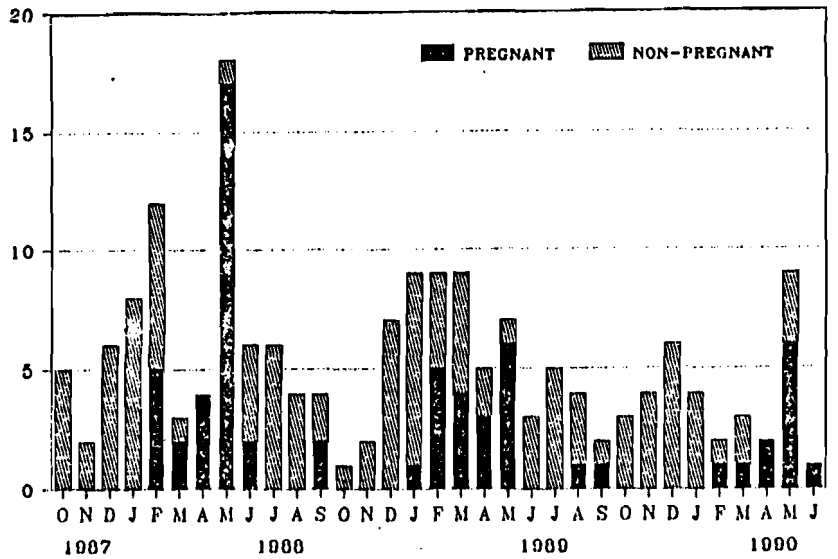

Fig. 2. Occurrence of visible pregnancy in adult wild boar.

Farrowing dates, taken from aged fetuses and back-dated young animals, are given in Fig. 3. Farrowing dates more accurately reflect the breeding seasons than did the pregnancy data. A strong breeding effort appeared in late 1987. A bimodal breeding curve occurred in 1988 while the pattern for 1989 is unimodal. Most births occurred in the months of April through September, with a few animals born in October and November. The breeding seasons were separated by a 3 or 4 month non-breeding period in the winter months.

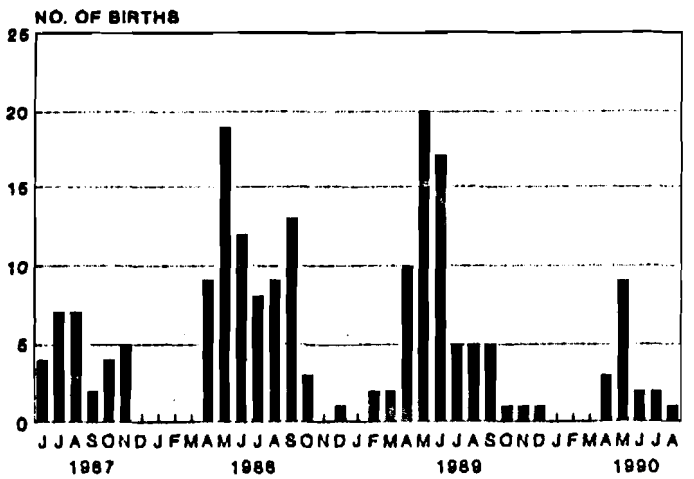

Fig. 3. Distribution of births determined from aged fetuses and young animals < 6 months.

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Seasonal changes in the adjusted weight of testis in the male wild boar are given in Fig. 4. In each year, the lowest weights occurred in the July to September quarter and the peak weights were seen in the months of January through March. The differences between the late summer quarters and the winter-spring quarters are significant ($p = 0.01$) each year.

Ovarian weights of females also fluctuated seasonally, with the lowest weights seen in the months of July through September (Fig. 5) and the peak weights in April, May and June. The difference between the peak and low weights is highly significant ($t = 4.53$, $p = 0.001$).

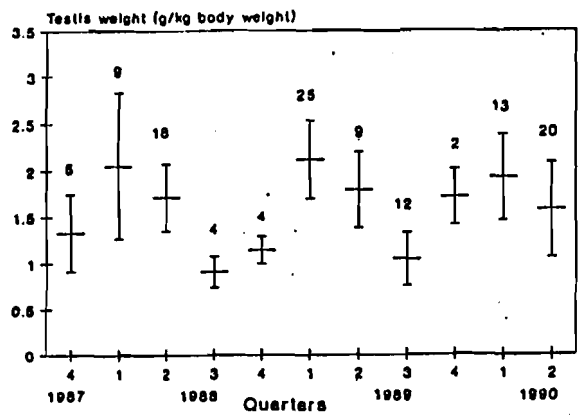

Fig. 4. Seasonal changes in testis weights (adjusted for body weight) of male wild boar (Means ± SD, sample size above the bar).

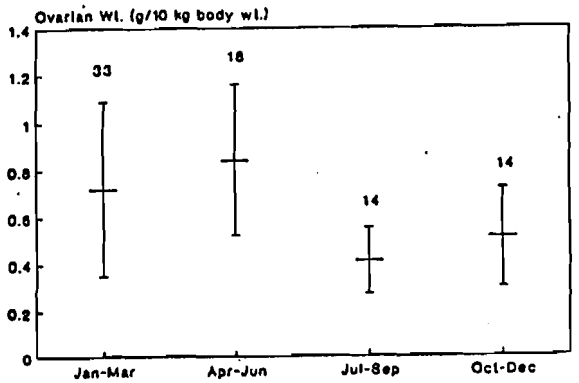

Fig. 5. Seasonal changes in ovarian weights (adjusted for body weight of females (Mean ± SD, sample size above the bar).

Litter Size

Litter size varied from 1 to 10 and averaged 5.65 ± 2.16 among the 61 females. Younger females, less than one year, had smaller litters (4.73 ± 1.98) than did females 2 years old or older. Surprisingly, yearling females averaged smaller litters (4.67 ± 1.71) than did the young-of-the-year breeders. The difference in litter size between young-of-the-year females and the older females was not significant ($t = 1.52$, $p = >.10$). There is a positive correlation between the number of fetuses and the weights and ages of pregnant females, as shown in Figs. 6 & 7.

We examined litter size by age classes of the fetuses, using three groups: 0-60 days, 61-90 days, and 91-115 days (Table 4). There was a decrease from a mean of 6.08 fetuses in early pregnancy to 5.41 in late pregnancy, representing an 8.9% loss of fetuses.

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Ovarian analysis of 17 pregnant females revealed 104 corpora lutea of pregnancy and a corresponding fetus count of 87, indicating an intrauterine loss of 16% of the shed ovum.

Table 4. Age of fetuses and mean litter size.

Fetuses age (days)	n	Mean Litter Size (± S.D.)
0 - 60	13	6.08 ± 2.02
61 - 90	20	5.60 ± 2.04
91 -115	27	5.41 ± 2.41

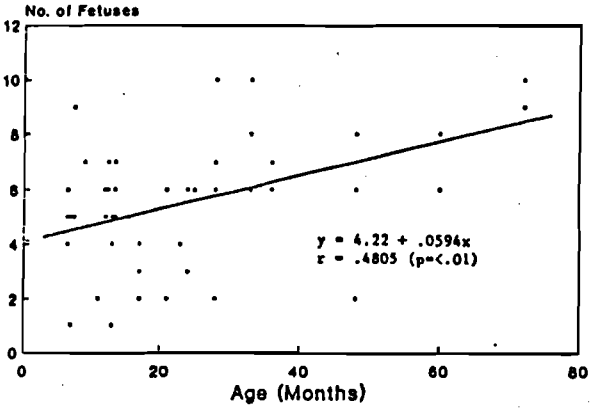

Fig. 6. Relationship of litter size to age of females.

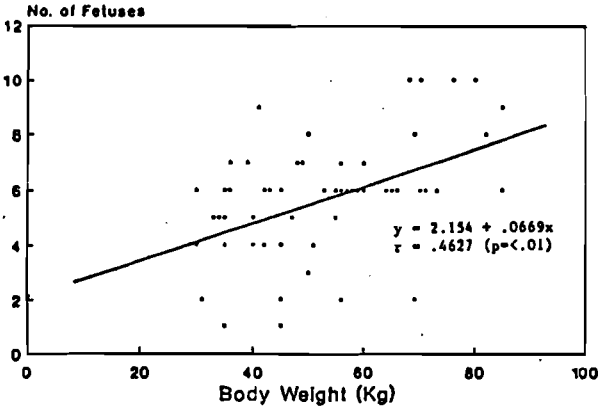

Fig. 7. Relationship of litter size to body weight of females.

Teats

The mean number of visible teats per female was 8.32 ± 0.94 (n = 209), ranging from 3 to 10. Eight (74.6%) and 10 (16.7%) were the most frequently encountered. This is less than the number found in domestic breeds (Plum 1938; Smith et al., 1938) and less than the 11.9 to 12.6 observed by Barrett (1978) in feral hogs in California.

Age and Productivity of Female

Table 5 details the productivity of several age classes of female wild boar. Young-of-the-year females, breeding before they are one year old, accounted for 23% of all observed pregnancies. The production per female for this group was the least of the age classes, 1.19 young/female. Yearling females do little better, accounting for 34% of all pregnancies but, because of small litters, produce only 1.31 young per female. The females two years

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old or older account for the real production of young in the collected sample. Overall production of young per female for the collection period was 1.78.

Table 5. Productivity of female wild boar

Age (mos.)	No. Examined	Percent Pregnant	Litter Size	Production of Young/Female
6-12	58	24.1	4.93 ± 1.98	1.19
13-24	75	28.0	4.67 ± 1.71	1.31
25-36	35	42.9	6.67 ± 1.91	2.86
>36	25	44.0	7.09 ± 2.30	3.12
Totals	193	31.6	5.65 ± 2.16	1.78

DISCUSSION

Sex and Age Structure

The sex ratio of 45.7% males to 54.3% females among the entire sample is somewhat different from those reported by Johnson et al. (1982) of 52% males to 48% females in European wild boar in Tennessee. Sex ratios reported by Fox and Pelton (1977) and Sweeney et al. (1979) on European wild boar and feral hogs, respectively, were more males than females. Only Conley et al. (1972) found a 47 male: 53 female sex ratio in hunter-harvested feral hogs on the Tellico Wildlife Management Area in Tennessee.

Barrett (1978) found the sex ratio of young feral hogs was 50 male: 50 female, while in adults (13+ months) the ratio was 46.4 males to 53.6 females. The ratio of young males (<12 months) in this study was only 44 males: 56 females but among adults (13+ months) was 47.9 males to 52.1% females, the latter being in agreement with Barrett's findings in California.

Sex ratios derived from hunted samples may have hunter-bias to collect trophy heads and hence shoot more males. Such was not the case in this study; all animals seen were shot at regardless of sex or age.

The age structure we observed of 48% young (less than or equal to 12 months), 29% yearlings (13-24 months), and 23% adults (>24 months) was similar to Barrett's (1978) age structure in feral hogs in California, except he found a larger proportion of older animals (28% >24 months). Other reported age structures (Johnson et al. 1982) were 52% <12 months old, 21% boars 12-26 months, and 27% >26 months old. Conley et al. (1972) found a lesser proportion of

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young: 31.6% hogs <12 months, 33.6% hogs 12-26 months, and 34.8% hogs >26 months for hunter-harvested hogs. Hunted samples have been shown to differ markedly from trapped samples, however, (Johnson et al. 1982, Fox and Pelton, 1977), which may partially explain the lesser proportion of young animals in Conley's, et al. (1972) sample.

These age structures suggest a high mortality in the Eurasian wild boar in Pakistan, indicating that only 52% of the animals may live to 12 months age and that by the end of 24 months only 23% of the population has survived. Maximum longevity is probably not much more than the estimated 6-plus years of the oldest animals.

Puberty

Male wild boar in Pakistan come into puberty in 5 months; by 7 to 8 months the majority (11 out of 16) were found with visible tubules in the cauda epididymis. Testis weights at this time averaged 46.0 gm (n=16). These findings are in agreement with Sweeney et al. (1979) who found that male feral wild hogs reached sexual maturation between 5 to 7 months. Barrett (1978) also found that male feral hogs in California attempted to breed at 6 months age. Other observers reported later sexual maturity in European wild boar, occurring between 7.5 and 12 months in Tennessee (Johnson et al. 1982). Weights of testis in Pakistan wild boar are in agreement with those found by Johnson et al. (1982) in Tennessee.

Female wild boar commenced breeding as early as 4 months while 5 others breed between 4.5 and 5 months old. Corpora lutea were first seen at 4 to 5 months in half the sample. Domestic sows normally produce Graafian follicles at an age of 3 to 4 months and breeding may be as early as 3 months but first successful breeding occurs at 6 to 7 months of age. In this respect the Pakistan wild boar differ from European wild boar which generally breed as yearlings (18 to 21 months) (Sludskii 1956, Haber 1969). In Tennessee, Johnson et al. (1982) found that European wild boar females reached puberty at approximately 6 months with a range of 5-8 months. The age at puberty in feral hogs appears later: Sweeney et al. (1979) reported 10 months to be the age of puberty of feral hogs in South Carolina; Barrett (1978) found puberty ranged between 6 and 8 months in feral sows in California; and Conley et al. (1972) reported an average breeding age of 9.2 months in 9 captive feral sows.

Litter Size

The fetal litter size, averaging 5.65 ± 2.16 for 61 females, is higher than that reported for the wild boar in Spain (Saez-Royuela and Telleria 1987), France (Aumaitre et al. 1984, Mauget 1972), and Germany (Briedermann 1971). It approximates litter sizes

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observed in other studies in Germany (Stubbe and Stubbe 1977), Austria (Martys 1982), and France (Mauget 1982).

European wild boar in the USA were found averaging only 3.0 per litter, but the sample was very small (Johnson et al. 1982). On other USA studies, the average litter size was 4.8 (Henry 1966, Conley et al. 1972).

Feral hogs appear to have larger litters. Barrett (1978) found 5.6 in California, Diong (1982) reported 5.9 in Hawaii and Sweeney et al. (1979) found 7.4 in South Carolina.

No resorbing fetuses were noted in our study. However, when we examined litter size at different ages of fetuses, a decrease from 6.08 mean fetal counts in early pregnancy to 5.41 in late pregnancy was found, representing a loss of 8.9% of fetuses. Asdell (1964) states that the stillborn loss in domestic sows averages 6%.

Productivity of Females

The young-of-the-year females did make a real contribution to the population. Representing 23% of all pregnant females in the three breeding seasons, they would have produced 69 young at birth. The older females would have produced 276 young. Thus, the young-of-the-year females contributed 20% to the total production of young at birth.

The productive age classes, however, remain the females aged 25 months or more. Litter size increases appreciably in the older females. Likewise, the frequency of pregnancy in the older females ran more than 40%. These two factors resulted in a production of young per female of 2.86 to 3.12 per litter.

Seasonality of Breeding

Pakistan wild boar exhibit seasonal breeding patterns. Most animals were born during the months of April through October. Conceptions occur during the fall and winter months of October into the following March, sometimes followed by another short mating period in May and June. These patterns of spring-summer births and a fall-winter mating period are similar to those reported by Mauget (1982) from France, in which unimodal and bimodal farrowing distributions were found. Smiet et al. (1979) reported on two pregnant females from lower Sind, Pakistan, that would have littered in March and the second half of April. Diong (1973) found that of 165 females killed by hunters from early February to early May, 56 (33.9%) were pregnant, indicating a winter/spring breeding season in western Malaysia.

These same general farrowing periods are also reported for the European wild boar by Briedermann (1971) in the German Democratic Republic and Aumaitre et al. (1984) in France. The patterns of

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farrowing in the European wild boar in the USA are somewhat different. Conley et al. (1972) reported that farrowing occurred in 2 peaks, predominantly in January and May. Sweeney et al. (1979) reported a January to February farrowing peak for feral hogs in South Carolina. Johnson et al. (1982) found that in the Great Smoky Mountains National Park farrowing occurred year round but a peak was found in late fall-early winter (Nov. - Jan.) and another in May.

Seasonality in the testes weights of male wild boar was not reported before. Sweeney et al. (1979) found no correlation between season and weight or volume of testes. Johnson et al. (1982) found no seasonal differences when total testes weight, expressed as a percentage of whole body weight, was plotted against the months of the year. We found ovarian weights changed seasonally also. Our observations suggest that both sexes are involved in the regulation of the breeding seasons.

Mauget (1982) has shown that wild boar breeding appeared to be photoperiodic. Anestrus increased in late spring as daylight increased and approached 100% in the sows by summer. The earliness or delay in the onset of the subsequent breeding season was conditioned by the availability of the mast crop in the forest in the autumn. In years of good mast production, breeding started in Oct./Nov., while it was delayed until Dec./Jan. in years of poor mast production. Baber and Coblentz (1987) concluded that the interaction of diet and photoperiod controlled the seasonality of breeding in feral pigs on Santa Catalina Island, California.

Photoperiod is the most probable environmental factor regulating seasonality in breeding in the wild boar in central Punjab, Pakistan. Breeding activity began in October 1988, following better than average rainfall in July, August and September. In the next season, breeding did not start until during the first week of January, 1990. In 1989, rainfall during the summer was below normal. Years of good summer rainfall would have led to better than average forage conditions for wild boar.

CONCLUSIONS

The Eurasian wild boar in Pakistan, even though a strongly seasonal breeder, has a high reproductive potential for a large mammal. This capability comes from 1) both sexes coming into puberty at the age of 5 to 6 months, 2) a litter size of 5 to 6 young at birth, 3) over 30% of the females 6 months or more in age were visibly pregnant, and 4) some animals breed a second time in a year.

The ramifications of these findings upon management strategies for this species means that large-scale population reduction at times of non-breeding would yield the most benefits. One of these times occurs toward the end of the breeding season in May and June. At this time, following the wheat harvest in central Punjab, wild boar are forced into marginal habitats and are more vulnerable to hunting, trapping, and poisoning. Females are also burdened

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with young. Large-scale population reduction at this time should be feasible. The second period would be from October to December when mating activity normally occurs. Wild boar are not as vulnerable in this period, since they tend to hide deep within sugarcane fields. Large-scale control by any means at this time would be difficult but extremely beneficial.

Acknowledgements

We thank Mr. Rashid Khan, Chaudhry Zaheer Khan, Mr. M. Aslam Shah and Mr. M. Mazhar for their help in the shooting and collection of the wild boar. Special thanks for Mr. Saleem Masih for field and laboratory assistance in the collection of animal tissues. We appreciate the laboratory assistance of Mr. Mohammad Ilyas and Mr. Liaqat Wahla for cleaning the jaws.

This work was supported with funds provided by the US Agency for International Development under the project "Food Security Management, Vertebrate Pest Control, PASA IPK-0491-P-1F-5017-06". We also thank the Pakistan Agricultural Research Council and the National Agricultural Research Centre, Islamabad for providing office and laboratory space for the project.

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