disturbed denned bears relocated directly to another den.

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LITERATURE CITED

ALT, G. L. 1978. Dispersal patterns of black bears in northeastern Pennsylvania—a preliminary report. Proc. East. Black Bear Workshop 4:186–199.

———. 1980. Hunting vulnerability of bears. Pa. Game News 51(7):7–10.

BEECHAM, J. J., D. G. REYNOLDS, AND M. G. HORNOCKER. 1983. Denning ecology of the black bear in west-central Idaho. Int. Conf. Bear Res. and Manage. 5:79–86.

CRAIGHEAD, F. C., JR., AND J. J. CRAIGHEAD. 1972. Grizzly bear prehibernation and denning activities as determined by radiotracking. Wildl. Monogr. 32. 35pp.

ERICKSON, A. W. 1964. An analysis of black bear kill statistics for Michigan. Pages 68–102 *in* The black bear in Michigan. Mich. Agric. Exp. Stn. Res. Bull. 4.

LECOUNT, A. L. 1983. Denning ecology of black bears in central Arizona. Int. Conf. Bear Res. and Manage. 5:71–78.

LENTFER, J. W., R. J. HENSEL, L. H. MILLER, L. P. GLENN, AND V. D. BERNS. 1972. Remarks on denning habits of Alaska brown bears. Int. Conf. Bear Res. and Manage. 2:125–132.

LINDZEY, F. C., AND E. C. MESLOW. 1976. Characteristics of black bear dens on Long Island, Washington. Northwest Sci. 50:236–242.

NOVICK, H. J., J. M. SIPEREK, AND G. R. STEWART. 1981. Denning characteristics of black bears, *Ursus americanus*, in the San Bernardino Mountains of southern California. Calif. Fish and Game 67:52–61.

REYNOLDS, H. V., J. A. CURATOLO, AND R. QUIMBY. 1976. Denning ecology of grizzly bears in northeastern Alaska. Int. Conf. Bear Res. and Manage. 3:403–409.

ROGERS, L. L. 1977. Social relationships, movements, and population dynamics of black bears in northeastern Minnesota. Ph.D. Thesis, Univ. Minnesota, Minneapolis. 194pp.

———, AND L. D. MECH. 1981. Interactions of wolves and black bears in northeastern Minnesota. J. Mammal. 62:434–436.

STONEBERG, R. P., AND C. J. JONKEL. 1966. Age determination of black bears by cementum layers. J. Wildl. Manage. 30:411–414.

TIETJE, W. D., AND R. L. RUFF. 1980. Denning behavior of black bears in boreal forest of Alberta. J. Wildl. Manage. 44:858–870.

WILLEY, C. H. 1974. Aging black bears from first premolar tooth sections. J. Wildl. Manage. 38: 97–100.

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DIFFERENTIATING MOUNTAIN LION AND BOBCAT SCATS

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The mountain lion (*Felis concolor*) is locally common in the western United States, but in the eastern United States the only known population exists in southern Florida (Belden 1978). Sighting reports are numerous throughout the East, but their credibility depends upon finding physical evidence to substantiate observers' claims. Scats are a source of physical evidence if positive identification can be made. In addition, many food habits studies are performed by analyzing scats, and there is no way to ensure that all samples included for study are from the target species. Visual identification is not always conclusive; several species of felids may deposit scats in scrapes, and there is overlap in scat and scrape size between species (Clinite 1981).

Recently, investigators studying fecal bile acids in scats from a variety of carnivores using thin-layer chromatographs reported that bile acid components of

mountain lion scats are distinctive (Major et al. 1980, Johnson et al. 1981). However, there was chemical similarity with some bobcat (*F. rufus*) scats (Aldred 1980, Clinite 1981). The objective of our study was to determine if thin-layer chromatographs of fecal bile acids can be used to distinguish between mountain lion and bobcat scats.

METHODS

Thin-layer Chromatography

Scats from 10 captive bobcats and 10 captive mountain lions were used to prepare standards for comparison with unknown samples (Aldred 1980). One gram of dried fecal material was used for each analysis. Following procedures reported by Major et al. (1980), dry fecal samples were extracted with at least 20 ml of benzene : methanol (1:1). Samples were filtered through a medium sintered glass filter, evaporated, and redissolved in 1 ml of benzene : methanol. Thirty microliters of each sample were spotted on the bottom of a 20-cm glass plate coated with a 250-μm-thick layer of silica gel G.

Gas Chromatography

To identify and quantify bile acids present in mountain lion and bobcat scats, four samples from each species consisting of 5 g of dried material per sample were analyzed by gas chromatography (GLC). Each sample was homogenized in 50 ml of methanol. Ten milliliters of 6.6 N NaOH were added and samples were refluxed for 1 hour to hydrolyze ester conjugate bonds. After the sample cooled, 50 ml of hexane were added, the mixture was shaken and centrifuged at 220 × *g*, and the upper hexane layer was removed with a large syringe. Hexane extraction was repeated four times and the extracts were discarded. This procedure removed neutral steroids while bile acids remained in the lower aqueous phase. The aqueous phase was saponified in an autoclave at 15 psi for 3 hours. After cooling, samples were acidified to pH 1 with 4 N HCl and extracted four times with diethyl ether. Extracts were pooled and allowed to stand for at least 12 hours. Samples were then evaporated and methylated by adding 15 ml of methanol and acetyl chloride (10:1). Flasks were stoppered and allowed to stand for at least 12 hours. Samples were dried and taken to 20 ml with 6 ml of chloroform : methanol (2:1) and 14 ml of diethyl ether. Four milliliters of each sample were applied to a silica gel GF (500-μm-thick) thin-layer plate that had been dried in an oven for 1 hour at 110 C. A standard solution containing methyl lithocholic and methyl cholic acids was also applied to each plate. Plates were developed twice in benzene to raise fatty acid methyl esters above bile acid methyl esters. A third development was made with isooctane : isopropanol : acetic acid (120:40:1). Rhodamine 6G was sprayed on the area containing the standards to identify the region containing the bile acid methyl esters. This area was scraped off the plate into a scintered glass filter, and bile acids were recovered by eluting with 60 ml of acetone. After evaporation, 1 mg of cholestane in 3 ml ethyl acetate was added to each sample for GLC internal standardization. Cholestane was used as a reference marker, as its presence in the sample is recorded before other bile acids. Samples were evaporated and gas chromatographed.

Analyses were performed with a Hewlett Packard 7610 A High Efficiency Gas Chromatograph equipped with flame ionization detectors, 7650A Electrometer, 19120 A Teletype Printer, and Beckman recorder. Injection port and flame ionization temperatures were maintained at

240 and 260 C, respectively. Columns were silanized 2-m glass U-tubes with 2-mm ID (Eneroth and Sjovall 1969). High-grade nitrogen gas with a flow rate of 60 ml/minute was used as the carrier.

Blind Samples

Belden mailed 144 numbered but otherwise unlabeled scats to Johnson for laboratory analysis. Scats were collected in the field by Belden and others. No scats thought to be from predators other than bobcat and mountain lion were included. Included among these field-collected scats were 14 and 24 randomly numbered scats from captive bobcats and mountain lions, respectively. All scats were examined visually by Johnson and tentatively identified based primarily on size. One gram of dried material was taken from each scat and subjected to thin-layer analysis.

RESULTS

Thin-layer chromatographs (TLC) of scats analyzed by Aldred (1980) had steroid bands at R_f (distance steroid band traveled on the 20-cm TLC plate divided by the distance traveled by the solvent) values of about 18 and 50% for mountain lion and at about 18, 28, 50, and 75% for bobcat. However, all bands were not present in every sample (Table 1). The intensity and size of each band on TLC plates were related to the concentration of material extracted from fecal samples. For bobcat samples, bands occurring at R_f's 18 and 50% were the most intense and occurred with highest frequency. Bands occurring at R_f's 28 and 75% were less frequent in bobcat scats and did not occur in any of the 10 known mountain lion scats.

Cholic, deoxycholic, chenodeoxycholic, and lithocholic acids were detected in mountain lion and bobcat scats by gas chromatography, whereas one bobcat scat contained hyodeoxycholic acid and three contained an unidentified bile acid (Table 2). Cholic acid plus its derivative, deoxycholic acid, averaged 75.2 ± 7.9% (±SE) of the bile acids recovered from bobcat scats and 94.4 ± 1.6% of bile acids recovered from mountain lion scats.

Blind samples were chemically identified as bobcat scats if they contained bands common to both cats plus either or both bands at 28 and 75%. Samples were chemically identified as mountain lion scats if they only contained bands at 18 and 50%. Scats that contained only one of the bands or no extractable bile acids were termed chemically unidentifiable.

Known Samples

Of all known samples, 64% of the bobcat scats and 79% of the mountain lion scats were correctly identified by thin-layer analysis. Four of the 14 known bobcat samples were misidentified as mountain lion scats, 9 were correctly identified, and 1 could not be identified chemically. Four of the 24 known mountain lion samples were misidentified as bobcat scats and 1 could not be identified chemically.

Twenty-one (88%) of the known mountain lion scats were correctly identified visually and 18 (86%) of these were also correctly identified chemically. One small mountain lion scat was visually misidentified and three amorphous scats were considered visually unidentifiable.

For the samples from known bobcats, nine (64%) were correctly identified visually and seven (78%) of these were correctly identified chemically. One bobcat sample was visually identified as a mountain lion scat, and four were considered visually unidentifiable.

No identification errors were made when visual and chemical identifications matched. Thus, 75% of the samples from mountain lions and 50% of those from bobcats were correctly identified by con-

Table 1. Locations and relative frequency of occurrence (%) for steroid bands on TLC plates prepared from fecal extracts of 10 bobcat and 10 mountain lion scats.

R_f location[a]	Bobcat	Mountain lion
18	87	60
28	67	0
50	83	100
75	33	0

[a] Distance traveled by the steroid band on 20-cm TLC plates divided by the distance traveled by the solvent front × 100.

firming visual identification with chemical analysis.

Field-collected Samples

For the 106 field-collected scats, 34 (32%) were amorphous and considered visually unidentifiable, and 29 (27%) and 43 (41%) were visually identified as mountain lion and bobcat scats, respectively. Of visually identified scats, 25 (86%) and 29 (67%) were chemically confirmed as mountain lion and bobcat scats, respectively (Table 3). For the visually unidentifiable scats, four and one were chemically identified as mountain lion and bobcat, respectively. The other 29 could not be identified chemically because they did not contain sufficient bile acids.

DISCUSSION

Although four different bile acids occur in both mountain lion and bobcat scats, only cholic and deoxycholic acids regularly occurred in mountain lion scats in concentrations detectable by thin-layer analysis. According to analysis by gas chromatography, these two compounds also comprised higher ($P < 0.05$) proportions of total bile acids in mountain lion scats than in bobcat scats. One distinguishing feature of mountain lion scat was that total bile acid concentrations were so low that only cholic and/or deoxycholic acids were detected by thin-layer chromatography of extracts from a 1-g sample. The presence of a variety of bile acids in scats from other North American carnivores suggests that this feature is indeed distinctive for mountain lion scats (Johnson et al. 1981). However, thin-layer analysis ap-

Table 3. Thin-layer chromatographic identification of scats from captive bobcats and mountain lions compared to thin-layer chromatographic identification of visually identified, field-collected samples.

Samples	N	Number identified: Mountain lion	Bobcat	Unidentified
Known animals				
Bobcat	14	4	9	1
Mountain lion	24	19	4	1
Field-collected samples				
Bobcat	43	6	29	8
Mountain lion	29	25	2	2
Unidentified	34	4	1	29

Table 2. Proportions (%) of bile acids in scats of bobcat and mountain lion determined by gas chromatography.

	Samples							
	Bobcat				Mountain lion			
Bile acid	1	2	3	4	1	2	3	4
Cholic	33.9	11.3	43.5	26.3	78.8	84.9	8.5	15.8
Deoxycholic	48.4	47.2	22.6	67.5	15.9	9.8	81.5	82.4
Chenodeoxycholic	1.0	18.9	6.6	0.0	5.0	4.7	5.0	0.9
Lithocholic	3.2	6.4	6.5	6.2	0.3	0.6	5.0	0.9
Hyodeoxycholic	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0
Unidentified	14.5	14.4	20.8	0.0	0.0	0.0	0.0	0.0

pears to be only about 80% accurate for mountain lion scats and about 65% accurate for bobcat scats.

Bile acids are remarkably stable—they have been detected in original proportions from 2,000-year-old coprolites taken from dry habitats (Lin et al. 1978). Fresh scats contained relatively large amounts of water-soluble materials, but many of our field-collected scats were highly weathered and contained relatively little extractable bile acid. Generally these scats did not contain sufficient bile acids for analysis. Many of the samples visually identified as bobcat scats did not appear to contain the bile acids that occur at R_f's of 28 and 75% on thin-layer plates and were chemically identified as mountain lion scats. Fresh samples usually contained expected components, so that when chemical evidence was combined with visual evidence, identification was more reliable than visual identification alone. Bile acids are soluble in water, and our results suggest that scats exposed to precipitation cannot be reliably identified.

Because bile acids are soluble in water and mountain lion scats contain lower concentrations of bile acids than bobcat scats, the probability of chemically mistaking a field-collected bobcat scat for a mountain lion scat is much greater than vice versa. No errors were made when visual and chemical identifications matched for known samples. Data for 75% of known mountain lion scats matched, hence use of both criteria should yield the most accurate identifications. At present, thin-layer chromatographic analysis for identification of mountain lion scats should be used as supplementary evidence to confirm visual identification of fresh scats.

Scats were visually identified without knowledge as to whether they were collected from a scrape or of the kinds of tracks present at the collection site. A field biologist may have these additional clues to a scat's identity. Consequently, visual identification in the field would probably be more accurate than laboratory examination. However, field collections may be made by inexperienced technicians, additional field signs are not always present, and scats may not have the characteristic felid odor. Further, there are a variety of factors that can affect the visual characteristics of scats, including health and size of animal, arthropod activity, diet, and weathering. Therefore, thin-layer analysis can be used to ensure that all scats used for a study are from the target species.

The distinct difference between mountain lion and bobcat scats in the proportions of total bile acid comprised of cholic plus deoxycholic acid suggests that GLC analysis would be more accurate. We did not test the accuracy of gas chromatography because the cost for analysis was prohibitive for the number of scats used in our study. However, analysis of reasonably fresh field-collected scats by gas chromatography should provide identifications that are more accurate than those obtained by thin-layer analysis, and the additional cost may be justified where extreme accuracy is required.

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LITERATURE CITED

ALDRED, D. R. 1980. Biochemical identification of carnivore scats. M.S. Thesis, Mississippi State Univ., Mississippi State. 16pp.

BELDEN, R. C. 1978. Florida panther investigation—a 1978 progress report. Pages 123–133 *in* R. R. Odum and L. Landers, eds. Proc. Rare and Endangered Wildlife Symp. Ga. Dep. Nat. Resour. Tech. Bull. WLr.

CLINITE, E. W. 1981. Biochemical analysis of mountain lion and bobcat scat: difference be-

tween species and sex. M.S. Thesis, San Jose State Univ., San Jose, Calif. 49pp.
ENEROTH, P., AND J. SJOVALL. 1969. Methods of analysis in the biochemistry of bile acids. Methods in enzymology. XV. Academic Press, New York, N.Y. 257pp.
JOHNSON, M. K., D. R. ALDRED, E. W. CLINITE, AND M. J. KUTILEK. 1981. Biochemical identification of bobcat scats. Proc. Bobcat Res. Conf. Nat. Wildl. Fed. Sci. and Tech. Ser. 6:92–96.
LIN, D. S., W. E. CONNOR, L. K. NAPTON, AND R. F. HEIZER. 1978. The steroids of 2000-year-old human coprolites. J. Lipid Res. 19:215–221.
MAJOR, M., M. K. JOHNSON, W. S. DAVIS, AND T. F. KELLOGG. 1980. Identifying scats by recovery of bile acids. J. Wildl. Manage. 44:290–293.

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VARIABILITY OF OBSERVED GROUP SIZES WITHIN COLLARED PECCARY HERDS

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Field studies of collared peccary (*Tayassu tajacu*) have described social behavior, herd structure, and home range (Ellisor and Harwell 1969, Schweinsburg 1969, Bissonette 1976, Byers 1981). The consensus of opinion regarding social behavior and herd structure of peccaries using relatively open habitats such as the Arizona succulent desert is summarized by Sowls (1978:195), "The peccary herd is a permanent social unit that moves, feeds and rests together." This concept is also applicable to peccaries in the coastal prairie of Texas (J. G. Teer, pers. commun.) and provides the basis for the census procedures most commonly used to estimate herd sizes. In both Arizona (G. I. Day, pers. commun.) and Texas, herd size estimates currently are based on a count of the number of individuals seen together at one time. Breakup of herds into subgroups is rare in Arizona (Schweinsburg 1969), whereas studies in Texas indicate that at times, especially during spring and summer, small groups of peccaries are not uncommon (Jennings and Harris 1953). Bissonette (1976) observed that herds in Big Bend National Park formed subgroups throughout the year. The general tendency, however, was for subgroup size to increase during the fall and eventually for all subgroups of each herd to coalesce into one territorial group during the breeding season.

The objectives of this study were to examine variability in group sizes within peccary herds and to evaluate the validity of the count technique for estimating herd sizes in South Texas.

STUDY AREA AND METHODS

Fieldwork was conducted on the 6,151-ha Chaparral Wildlife Management Area (CWMA) in Dimmit and LaSalle counties, approximately 165 km southwest of San Antonio, Texas. This area has been owned and operated by the Texas Parks and Wildlife Department since 1969. Vegetation was representative of much of the brush country of the Rio Grande Plains in Texas. The dominant vegetation was honey mesquite (*Prosopis glandulosa*), with an understory of spiny hackberry (*Celtis pallida*), bluewood condalia (*Condalia obovata*), and Lindheimer pricklypear (*Opuntia lindheimeri*). Blackbrush acacia

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