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PHOTOGRAPH.

NORTH FAÇADE OF LION HOUSE.

Showing the completed pediment, and sentinel lions by Mr. Eli Harvey.

ELWIN R. SANBORN.

EIGHTH ANNUAL REPORT  
OF THE  
NEW YORK  
ZOOLOGICAL SOCIETY

CHARTERED IN 1895

OBJECTS OF THE SOCIETY  
A PUBLIC ZOOLOGICAL PARK  
THE PRESERVATION OF OUR NATIVE ANIMALS  
THE PROMOTION OF ZOOLOGY

1903



NEW YORK  
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ABERCROMBIE, DAVID T.....	314	Broadway
ADAMS, FRANK LANSON.....	38	East 51st Street
ADAMS, FREDERICK T.....	10	Wall Street
ADAMS, THATCHER M.....	15	West 17th Street
ADRIANCE, REV. HARRIS ELY.....	122	East 36th Street
AGNEW, ANDREW G.....	45	Wall Street
AGNEW, MRS. CORNELIUS R.....		Palisades, N. Y.
AITKEN, JOHN W.....	873	Broadway
ALDRICH, MRS. H. D.....	200	Madison Avenue
ALDRICH, MRS. JAMES HERMAN.....	150	West 59th Street
ALEXANDER, FRANK D.....	125	West 44th Street
ALEXANDER, JAMES W.....	4	East 64th Street
ALEXANDER, DR. WELCOME T.....	940	St. Nicholas Avenue
ALEXANDRE, J. HENRY.....	35	East 67th Street
ALLEN, JAMES LANE.....	66	Fifth Avenue
ALLGOEVER, A.....	3068	Third Avenue
ANDERSON, A. A.....	6	East 38th Street
ANDERSON, P. CHAUNCEY.....	25	Broad Street
ANDREINI, J. M.....	29	West 75th Street
ANGELL, AMASA R.....	203	Broadway
*ANGUS, JAMES.		
APPLETON, FRANCIS R.....	21	Maiden Lane
APPLETON, JAMES W.....		Knickerbocker Club
ARCHBOLD, JOHN D.....	26	Broadway
AUCHINCLOSS, MRS. EDGAR S.....	24	East 48th Street
AUCHINCLOSS, JOHN W.....	22	William Street
AUSTIN, GEORGE C.....	192	Broadway
AYCRIGG, B. ARTHUR.....	171	West 71st Street
AYER, FREDERICK F.....	15	Broad Street
BAKER, STEPHEN.....	40	Wall Street
BALCOM, DR. IRVING S.....	587	Fordham Road
BALDWIN, DR. JARED G.....	8	East 41st Street
BALDWIN, JARED G., JR.....	33	Wall Street
BALFOUR, FREDERICK R. S.....		Dawyck, Stobo, Peebleshire, Scotland
BANGS, L. BOLTON.....	39	East 72d Street
BANKS, THEO. H.....	29	Nassau Street
BARBER, GEN. THOMAS H.....	45	East 68th Street
BARNES, J. SANFORD.....	10	East 79th Street

\*Deceased.

BARNEY, ASHBEL H.....	67 Park Avenue
BARNEY, MISS KATHARINE L.....	67 Park Avenue
BARNEY, MRS. J. STEWART.....	40 West 38th Street
BARNEY, N. C.....	49 West 44th Street
BARR, WILLIAM.....	Llewellyn Park, Orange, N. J.
BARRON, DR. JOHN C.....	35 Broadway
BARRON, GEORGE D.....	Harrison, Westchester Co., N. Y.
BARTELS, WILLIAM.....	160 Greenwich Street
BAXTER, GEORGE S., JR.....	17 William Street
BAYARD, LOUIS P.....	47 Cedar Street
BAYLIES, EDMUND L.....	54 Wall Street
BAYLIES, MRS. NATHALIE E.....	1 East 71st Street
BAYLIS, WILLIAM.....	15 Wall Street
BEACH, F. C.....	9 West 20th Street
BEADLESTON, ALFRED N.....	36 West 35th Street
BEAL, WILLIAM R.....	1 West 121st Street
BEARD, DANIEL C.....	Flushing, L. I.
BECKER, C. E.....	Scarborough, N. Y.
BECKER, CHRISTIAN.....	3 Davenport Avenue, New Rochelle, N. Y.
BECKER, PHILIP.....	1030½ East 175th Street
BEEBE, C. WILLIAM.....	New York Zoological Park
BEERBOWER, GEORGE M.....	New York Zoological Park
BEERS, M. H.....	408 Broadway
BELMONT, PERRY.....	580 Fifth Avenue
BENEDICT, MISS LOUISE.....	10 West 51st Street
BENSON, FRANK SHERMAN.....	214 Columbia Heights, Brooklyn
BEROLZHEIMER, E.....	377 Broadway
BICKMORE, PROF. ALBERT S.....	American Museum of Natural History
BIEN, FRANKLIN.....	1032 Fifth Avenue
BIGELOW, H. B.....	Oxford Street, Cambridge, Mass.
BILLINGS, FREDERICK.....	279 Madison Avenue
BILLINGS, H. B.....	29 Maiden Lane
BILLINGS, MISS MARY M.....	279 Madison Avenue
BIRCHALL, W. H.....	177th Street, Bronx River
BIRD, GEORGE.....	202 Madison Avenue
BLAGDEN, GEORGE.....	18 East 36th Street
BLAGDEN, MRS. JULIA G.....	18 Gramercy Park, New York
BLAIR, D. C.....	24 Broad Street
BLAIR, J. INSLEY.....	6 East 61st Street
BLAKE, DR. JOSEPH A.....	601 Madison Avenue
BLAKESLEE, T. J.....	353 Fifth Avenue
BLISS, ERNEST C.....	30 Fifth Avenue
BLODGETT, MRS. WILLIAM T.....	24 West 12th Street
BLOODGOOD, ROBERT F.....	56 West 37th Street
BLOOMINGDALE, JOSEPH B.....	78 Fifth Avenue
BLOOMINGDALE, LYMAN G.....	992 Third Avenue
BLOSS, JAMES O.....	21 East 47th Street
BLUMENSTIEL, A.....	108 East 79th Street
BOAS, EMIL L.....	37 Broadway
BODMAN, MRS. ED. C.....	835 Madison Avenue
BOOKELMAN, PROF. BERNARDUS.....	106 West 45th Street
BOETTGER, H. W.....	2144 Fifth Avenue
BOETTGER, THEODORE M.....	Lodi, Bergen County, N. J.
BOGERT, EDWARD C.....	112 East 39th Street
BOISSEVAIN, G. L.....	572 Madison Avenue
BOLL, HENRY.....	3854 Southern Boulevard
BOLTON, MISS CATHERINE E.....	406 Jefferson Avenue, Brooklyn
BOLTON, JOHN W.....	1777 West Farms Road
BOLTON, THOMAS, JR.....	Minford Place, Boston Avenue



BOLTON, WILLIAM H.	Boston Road, West Farms
BOND, ALFRED H.	127 Fifth Avenue
BOND, WILLIAM EDWARD.	100 Broadway
BONNER, PAUL R.	Stamford, Conn.
BORGSTEDE, JOHN G.	968 Trinity Avenue
BORLAND, WILLIAM G.	17 Broad Street
BORNE, JOHN E.	205 West 57th Street
BORROWE, H. A.	1037 Fifth Avenue
BOWDOIN, TEMPLE.	104 East 37th Street
BOWERS, JOHN M.	7 West 21st Street
BRADFORD, J. H.	Union Club
BRADLEY, EDSON.	45 Broadway
BRADY, MRS. J. R.	84 Maple Avenue, Flushing, L. I.
BRAININ, FRED.	549 Buckhout Avenue
BRANNAN, DR. JOHN W.	11 West 12th Street
BRAUN, FRED.	691 East 143d Street
BREEN, MATTHEW P.	1818 Clay Avenue
BREIDENBACH, CHARLES M.	West Farms
BRETT, GEORGE P.	Darien, Conn.
BREWER, WILLIAM A., JR.	141 Broadway
BREWSTER, MRS. BENJAMIN.	695 Fifth Avenue
BREWSTER, GEORGE S.	51 Wall Street
BRINCKERHOFF, ELBERT A.	Englewood, N. J.
BRISTOL, PROF. CHARLES L.	New York University
BRISTOL, JNO. I. D.	45 West 74th Street
BRISTOW, WILLIAM B.	20 Nassau Street
BRONSON, DR. EDWARD BENNET.	10 West 49th Street
BROWN, MISS E. W.	524 Fifth Avenue
BROWN, HON. ADDISON.	45 West 89th Street
BROWN, JOHN CROSBY.	36 East 37th Street
BROWN, WALDRON P.	32 East 35th Street
BROWNING, WILLIAM C.	552 Fifth Avenue
BROWNING, WILLIAM H.	18 West 54th Street
BROWNLEE, ARTHUR A.	52 Wall Street
BRYANT, DR. JOSEPH D.	32 West 48th Street
BRYCE, MRS. WILLIAM.	20 West 54th Street
BUCKHOUT, WILLIAM H.	615 Tremont Avenue
BUCKNALL, HENRY W. J.	305 West 75th Street
BUDD, HENRY A.	121 West 72d Street
BULKLEY, EDWIN M.	54 William Street
BULL, ROBERT MACLAY.	40 East 40th Street
BULL, WILLIAM L.	38 Broad Street
BULL, DR. WILLIAM T.	35 West 35th Street
BUMPUS, HERMON C.	American Museum Natural History
BURDEN, JAMES A., JR.	174 Madison Avenue
BURDEN, JOSEPH W.	Union Club
BURDICK, FORD S.	Anita, North Dakota
BURKAM, MRS. CAROLINE TOUSEY.	Plaza Hotel
BURLEIGH, GEORGE W.	52 Wall Street
BURNHAM, MRS. DOUGLAS W.	Fishkill-on-Hudson, N. Y.
BURR, WINTHROP.	7 Wall Street
BUSH, JOHN S.	Tremont and Webster Avenues
BUTT, GEN. McCOSKRY.	8 West 52d Street
CALHOUN, HENRY W.	54 Wall Street
CALMAN, HENRY L.	18 East 23d Street
CAMMANN, HERMANN H.	Merrick, L. I.
CAMMANN, HENRY LORILLARD.	Box 391, New York City
CAMP, FREDERICK EDGAR.	Morris Heights, N. Y.
CANFIELD, GEORGE FOLGER.	32 East 33d Street

CANFIELD, JOSEPH B.	Bridgeport, Conn.
CANNON, JAMES G.	14 Nassau Street
CARDEZA, T. D. M.	43 East 49th Street
CAREY, H. T.	42 New Street
CARNOCHAN, GOUVERNEUR M.	Riverdale-on-Hudson
CARPENDER, WILLIAM.	44 Pine Street
CARPENTER, PHILIP.	38 Park Row
CARROLL, ROYAL PHELPS.	Knickerbocker Club
CARTER, L. AVERELL.	204 West 86th Street
CARTER, WALTER S.	176 Brooklyn Avenue, Brooklyn
CASE, E. R.	1 West 81st Street
CASSATT, G. M.	19 West 34th Street
CASTREE, JOHN W.	150 Central Park South
CASWELL, JOHN H.	11 West 48th Street
CATHCART, MISS JENNIE R.	The Barnard, 108 Central Park West, care Munroe & Cie., 7 rue Scribe, Paris, France
CERERO, R. L.	321 Hancock Street, Brooklyn, N. Y.
CHABOT, S. J.	150th Street and Third Avenue
CHAMBERS, FRANK R.	842 Broadway
CHAMBERS, JAMES.	277 South Street, Morristown, N. J.
CHAMBERS, JOHN A.	277 South Street, Morristown, N. J.
CHAPMAN, FRANK M.	American Museum of Natural History
CHESEBROUGH, ROBERT A.	51 East 49th Street
CHICHESTER, CHARLES DARWIN.	46 Wall Street
CHISHOLM, B. OGDEN.	436 Madison Avenue
CHITTENDEN, JARED.	1 West 30th Street
*CHRISTIE, WILLIAM F.	
CHURCH, F. S.	Carnegie Hall
CHURCH, THEO. W.	354 Charlton Avenue, South Orange, N. J.
CLAFLIN, JOHN.	4 East 72d Street
CLARK, D. CRAWFORD.	51 Wall Street
CLARK, J. MITCHELL.	45 Wall Street
CLARK, L. C.	51 Wall Street
CLARK, W. A.	49 Wall Street
CLARK, WILLIAM N.	170 William Street
CLARKE, C. C.	Scarborough, N. Y.
CLARKE, THOMAS F.	1701 Madison Avenue
CLARKE, THOMAS SHIELDS.	50 Riverside Drive
CLAUSEN, GEORGE C.	32 West 69th Street
CLEARY, JOHN.	121 Madison Avenue
CLEMENTS, G. H.	Bowne Avenue, Flushing, L. I.
CLEVELAND, CHARLES D.	54 East 52d Street
CLYDE, WILLIAM P.	P. O. Box 1194, New York City
COCKERILL, JOHN F.	147 Columbus Avenue
COCKEROFT, MISS E. V.	147 Madison Avenue
COCKRAN, W. BOURKE.	31 Nassau Street
COFFIN, WILLIAM E.	31 Nassau Street
COHEN, SAMUEL M.	127 Bleecker Street
COLBURN, N. A.	808 Broadway
COLE, E. F.	253 Broadway
COLLARD, GEORGE W.	884 Fifth Avenue
COLLIER, PRICE.	Tuxedo Park, N. Y.
COLLIER, P. F.	29 Fifth Avenue
COLLINS, DR. STACY BUDD.	5 West 57th Street
COLLINS, MRS. ELLEN.	41 West 11th Street
COLLINS, MISS GERTRUDE.	Care Stephen W. Collins, 69 Wall Street
COMFORT, WALTER R.	944 St. Nicholas Avenue
COMSTOCK, MRS. H. G.	100 East 17th Street

\*Deceased.

CONDON, THOMAS GERALD.....	Tuxedo Park, N. Y.
COOPER, EDWARD.....	12 Washington Square North
CORBIN, AUSTIN.....	192 Broadway
CORNING, C. R.....	Union League Club
CORNING, G. M.....	P. O. Box 501, New York City
CORWINE, WILLIAM R.....	55 East 76th Street
COSTAINE, EUGENE H.....	Shrub Oak, Westchester Co., N. Y.
COSTER, HENRY A.....	Westchester, New York City
COTTON, W. J.....	52 Wall Street
COWDIN, WINTHROP.....	Mt. Kisco, N. Y.
COWL, CLARKSON.....	20 West 14th Street
COWLES, DAVID S.....	66 Broadway
COX, CHARLES F.....	54 East 67th Street
COX, JENNINGS S.....	10 Wall Street
CRAIGIE, ARCHIBALD WALPOLE.....	57 West 46th Street
CRANE, ALBERT.....	Stamford, Conn.
CRAWFORD, DR. W. H.....	205 West 57th Street
CROMWELL, JAMES W.....	1 Greene Street
CRONIN, CHARLES H.....	2496 Cambreling Avenue
CROSBY, LIVINGSTON.....	Dobbs Ferry, N. Y.
CRUICKSHANK, JAMES.....	275 Central Park West
CURTIS, EDWARD W.....	155 Worth Street
CUTTER, RALPH L.....	219 Clinton Street, Brooklyn
CUTTING, R. FULTON.....	32 Nassau Street
CUTTING, W. BAYARD.....	24 East 72d Street
DAINTRY, W. MANSELL.....	103 East 29th Street
DAMON, WILLIAM E.....	222 West 23d Street
DANA, WILLIAM B.....	76½ Pine Street
DANIELS, GEORGE H.....	Grand Central Depot
DANNE, DR. FREDERIC.....	44 West 50th Street
DARDS, CHARLES A.....	44th Street and Madison Avenue
DAVENPORT, IRA.....	31 East 39th Street
DAVIES, WILLIAM GILBERT.....	22 East 45th Street
DAVIS, GHERARDI.....	44 Pine Street
DAVIS, JOHN W. A.....	21 West 14th Street
DAVIS, JOSEPH P.....	201 West 55th Street
DAVIS, WILLIAM HARPER.....	New York Zoological Park
DAVISON, CHARLES STEWART.....	56 Wall Street
DAVISON, G. HOWARD.....	51 East 49th Street
DAY, HORACE LINCOLN.....	101 West 84th Street
DEAN, BASHFORD.....	Columbia University
DE COPPET, HENRY.....	22 West 17th Street
DEEVES, RICHARD.....	58 West 83d Street
DE FOREST, GEORGE B.....	14 East 50th Street
DE FOREST, ROBERT W.....	7 Washington Square North
DEGENER, J. F.....	5 West 38th Street
DE KLYN, B. F.....	64 Irving Place
DELAFIELD, FREDERICK P.....	29 Liberty Street
DELESKER, CHARLES.....	680 Tremont Avenue
DENICKE, J. B.....	1041 East 176th Street
DENNERLEIN, GEORGE.....	2063 Honeywell Avenue
DERBY, DR. RICHARD H.....	9 West 35th Street
DE RHAM, H. CASIMIR.....	Tuxedo, N. Y.
DEUTSCH, MORRIS.....	407 East 70th Street
DEVEREUX, W. B.....	99 John Street
DE VINNE, THEODORE LOW.....	300 West 76th Street
DEVLIN, JOHN B.....	148th Street and Third Avenue
DEVLIN, JOHN H.....	148th Street and Third Avenue
DE WITT, WALTER G.....	201 East 12th Street

DE WITT, WILLIAM G.....	10 West 30th Street
DEXTER, STANLEY W.....	71 Broadway
DEYO, ROBERT E.....	106 West 48th Street
DICKERSON, E. N.....	141 Broadway
DICKEY, CHARLES D.....	59 Wall Street
DIEHL, GEORGE H.....	18 West 127th Street
DIENST, A. P.....	Third Avenue and 140th Street
DILLON, WILLIAM B.....	49 Wall Street
DITMARS, R. L.....	New York Zoological Park
DIXON, GEORGE A.....	15 West 49th Street
DODGE, NORMAN W.....	156 Fifth Avenue
DOHSE, JOHN.....	717 Park Avenue
DOMINICK, H. BLANCHARD.....	14 West 49th Street
DOMMERICH, L. F.....	314 West 75th Street
DOREMUS, F. S.....	20 Nassau Street
*DORMITZER, MRS. HENRY D.	
DOUBLEDAY, F. N.....	34 Union Square East
DOUGLAS, JAMES.....	99 John Street
DOUGLASS, A. B.....	Flagstaff, Me.
DOWS, TRACY.....	8 Broadway
DRAKE, JOHN J.....	58 William Street
DRAKE, WILLIAM H.....	37 West 22d Street
DRAKENFELD, B. FERDINAND.....	27 Park Place
DRAYTON, J. COLEMAN.....	63 Wall Street
DRAZ, F.....	36 East 57th Street
DRESSEL, JOHN A. H.....	Hartford Building, 17th Street and Broadway
DRUMMOND, I. WYMAN.....	436 West 22d Street
DUANE, RICHARD BACHE.....	62 East 55th Street
DUER, WILLIAM A.....	115 Broadway
DUGMORE, A. RADCLIFFE.....	Newfoundland, N. J.
DUNCAN, W. BUTLER.....	1 Fifth Avenue
DUNCAN, STUART.....	392 Canal Street
DUNHAM, EDWARD K.....	338 East 26th Street
DUNHAM, G. H.....	19 West 81st Street
DUNNE, EDWARD B.....	54 West 30th Street
DUNNE, JAMES.....	31 Nassau Street
DURYEA, HARRY H.....	80 Madison Avenue
DURYEA, GEN. HIRAM.....	80 Madison Avenue
DUTCHER, WILLIAM.....	525 Manhattan Avenue
EBERHARDT, MARCUS.....	1462 First Avenue
EDGAR, D.....	Greenport, Suffolk Co., N. Y.
EDGAR, MISS JULIA L.....	28 East 39th Street
EDGAR, NEWBOLD.....	28 East 39th Street
EDGAR, HERMAN L. R.....	31 Nassau Street
EDGELL, GEORGE S.....	192 Broadway
EDMONDS, JOHN W.....	128 East 44th Street
EGERTON, M.....	9 Seamore Place, May Fair, London, England
EGGELING, OTTO.....	72 East 125th Street
EGLSTON, D. S.....	166 South Street
EHLERS, OTTO.....	1901 Washington Avenue
EIDLITZ, ROBERT JAMES.....	995 Madison Avenue
ELBERS, MRS. FRITZ.....	505 Fifth Avenue
ELDER, MRS. MATILDA A.....	25 East 30th Street
ELDRIDGE, FREDERICK L.....	66 Broadway
ELDRIDGE, LEWIS A.....	30 Broad Street
ELDRIDGE, ROSWELL.....	Great Neck, L. I.
ELLSWORTH, DUNCAN S.....	Calumet Club
ELLSWORTH, JOHN MAGEE.....	110 East 36th Street

\*Deceased

ELLSWORTH, LINCOLN.....	18 East 53d Street
*ELLSWORTH, WILLIAM.....	
EMERY, JOHN J.....	5 East 68th Street
EMMET, C. TEMPLE.....	134 East 71st Street
EMMET, MISS L. F.....	New Rochelle, N. Y.
EMMET, ROBERT TEMPLE.....	11 Front Street, Schenectady, N. Y.
ENDICOTT, ROBERT.....	1 East 35th Street
ENGERMAN, JOHN T.....	335 East 18th Street, Flatbush, L. I.
ENGLISH, E. M.....	687 Eleventh Avenue
ENO, JOHN CHESTER.....	P. O. Box 1889, New York
EPSTEAN, EDWARD.....	147 West 111th Street
ERBSLOH, F.....	134 East 60th Street
ESCHMANN, F. W. R.....	Yonkers, N. Y.
ESLING, WILLIAM W.....	1736 Bathgate Avenue
ETTLINGER, LOUIS.....	40 East 73d Street
EUSTIS, JOHN E.....	80 Broadway
EVANS, MRS. CADWALADER.....	9 East 10th Street
EVANS, RICHARD.....	93 William Street
EVARTS, A. W.....	52 Wall Street
EVARTS, SHERMAN.....	52 Wall Street
FAAS, JOHN.....	1351 Washington Avenue
FABBRI, ALESSANDRO.....	Scarborough, N. Y.
FABBRI, ERNESTO G.....	Scarborough, N. Y.
FAHNESTOCK, HARRIS C.....	2 Wall Street
FAHNESTOCK, WILLIAM.....	2 Wall Street
FAIRCHILD, DAVID.....	182 Benham Avenue, Bridgeport, Conn.
FAIRCHILD, H. S.....	52 Wall Street
FAIRCHILD, NELSON.....	119 East 40th Street
FALK, GUSTAV.....	24 East 81st Street
FALVEY, FRANK A.....	2081 Crotona Avenue
FARGO, JAMES C.....	56 Park Avenue
FARNHAM, PAULDING.....	15 Union Square
FARRAR, NATHANIEL B.....	281 Fifth Avenue
FIELD, WILLIAM B. OSGOOD.....	2 West 52d Street
FISHER, L. G.....	42 New Street
FISKE, J. W.....	41 Park Place
FITCH, EZRA H.....	Montclair, N. J.
FITZGERALD, GEN. LOUIS.....	253 Lexington Avenue
FOOT, J. D.....	Rye, N. Y.
FORBACH, CHARLES.....	1919 Prospect Avenue
FOSTER, EDWARD W.....	134 Leonard Street
FOSTER, GIRAUD.....	18 Wall Street
FOSTER, M. G.....	876 St. Nicholas Avenue
FOSTER, PELL W.....	126 Liberty Street
FOSTER, SCOTT.....	395 Canal Street
FOSTER, W. BERT.....	Box 66, Madison Square P. O., N. Y.
FOWLER, OTIS L. R.....	1263 East 179th Street
FOX, AUSTEN H.....	Holworthy 5, Cambridge, Mass.
FOX, JOHN J.....	1908 Bathgate Avenue
FRASER, ALEX V.....	440 Canal Street
FRASER, MRS. GEORGE S.....	667 Madison Avenue
FRISSELL, A. S.....	530 Fifth Avenue
FULDA, DR. CARL.....	107 Kent Street, Brooklyn
FULDA, DR. CLEMENS.....	107 Kent Street, Brooklyn
FULLER, CHARLES D.....	25 West 9th Street
FULLER, MRS. EUGENE.....	252 Lexington Avenue
FULTON, JOHN, JR.....	443 West 44th Street
FUNKE, EDMUND A.....	854 East 165th Street

\*Deceased.

GANNON, BARTHOLOMEW.....	1628 Second Avenue
GANZ, ANTHONY.....	2146 Boston Road
GARRETT, JOHN W.....	11 South Street, Baltimore, Md.
GAUTIER, DUDLEY G.....	32 Cliff Street
GAY, JOSEPH E.....	Union League Club
GEER, MRS. WALTER.....	246 West 72d Street
GERARD, MRS. JAMES W.....	725 Fifth Avenue
GERRISH, JOHN BROWN.....	Care of William L. Gerrish, 102 East 57th Street
GERSTER, DR. ARPAD G.....	34 East 75th Street
GHEE, JOHN F.....	Poplar Street, Westchester
GHEE, THOMAS.....	Eastchester Road, Williamsbridge, N. Y.
GIBNEY, DR. VIRGIL P.....	16 Park Avenue
GILBERT, CLINTON.....	48 East 50th Street
GILFORD, ROBERT.....	203 Main Street, Orange, N. J.
GILLETTE, CURTENIUS.....	24 West 40th Street
GILSEY, HENRY, JR.....	10 East 36th Street
GLEASON, MICHAEL.....	1893 Washington Avenue
GODDARD, F. N.....	273 Lexington Avenue
GOLDSCHMIDT, S. A.....	71 Central Park West
GOOD, MARTIN Q.....	233 East 87th Street
GOODHUE, MRS. S. C.....	189 Madison Avenue
GOODWIN, REV. FRANCIS.....	Box 345, Hartford, Conn.
GOTTHOLD, FREDERIC.....	165 West 58th Street
GOULD, CHARLES A.....	25 West 33d Street
GOULD, C. W.....	5 Washington Square
GOULD, EDWIN.....	195 Broadway
GOULD, GEORGE H.....	Santa Barbara, Cal.
GOULDEN, JOSEPH A.....	2433 Creston Avenue, Fordham
*GRACE, WILLIAM R.....	
GRANT, R. S.....	Union Club
GRAVES, WILLIAM L.....	Calumet Club
*GRAY, J. H.....	
GRANBERY, W. H.....	29 West 53d Street
GREEFF, ERNEST F.....	37 West 88th Street
GREENE, GEN. FRANCIS V.....	11 Broadway
GREENOUGH, JOHN.....	31 West 35th Street
GREENWOOD, ISAAC J.....	271 West End Avenue
GREER, CHARLES.....	Rye, N. Y.
GRIFFITH, DANIEL J.....	21 West 59th Street
GRINNELL, GEORGE BIRD.....	346 Broadway
GRINNELL, WILLIAM MORTON.....	873 Madison Avenue
GRISWOLD, CHESTER.....	23 West 48th Street
GROSS, FRANK.....	1345 Lexington Avenue
GROSSMAN, GEORGE J.....	952 Trinity Avenue
GUDEWILL, REV. RUDOLPH H. E.....	30 West 59th Street
GULLIVER, W. C.....	120 Broadway
GURNEE, W. S., JR.....	417 Fifth Avenue
HAAS, OTTO.....	1882 Bathgate Avenue
HADDEN, DR. ALEXANDER.....	155 East 51st Street
HAGGERTY, MRS. JANET B. H.....	2 East 45th Street
HAINES, HENRY F.....	2 Wall Street
HALL, HENRY E.....	1269 East 179th Street
HALLOCK, CHARLES P.....	180th Street and Honeywell Avenue
HALSTEAD, MISS L. P.....	110 East 37th Street
HAMERSLEY, LOUIS GORDON.....	1030 Fifth Avenue
HAMILTON, THEODORE.....	1028 Grote Street
HAMMOND, JAMES B.....	The Osborne, Broadway and 57th Street
HAMMOND, MRS. JOHN HENRY.....	14 East 72d Street

\*Deceased.

HANFORD, DR. H. W.....	Wyoming, N. J.
HANSON, PROF. HARRY D.....	310 East 21st Street
HARBECK, CHARLES T.....	Islip, N. Y.
HARD, ANSON W.....	107 Wall Street
HART, WILLIAM W.....	365 Fifth Avenue
HARTOG, FERDINAND J., JR.....	21 East 99th Street
HARVEY, ELI.....	80 East Washington Square
HASBROUCK, HAROLD.....	39 West 90th Street
HASSLACHER, JACOB.....	100 William Street
HATFIELD, THOMAS F.....	834 Hudson Street, Hoboken, N. J.
HAVEMEYER, T. A.....	117 Wall Street
HAVENS, ALBERT G.....	East Orange, N. J.
HAVEN, GEORGE G., JR.....	6 East 53d Street
HAWLEY, E.....	25 Broad Street
HAYNES, WILLIAM DE FOREST.....	16 East 36th Street
HECKSCHER, JOHN GERARD.....	31 West 75th Street
HEIMAN, ABRAHAM.....	745 East 175th Street
HEIMAN, E.....	745 East 175th Street
HEIMAN, MRS. SOPHIE.....	765 East 176th Street
HEINS, GEORGE L.....	303 State Street, Albany
HEINSHEIMER, L. A.....	54 William Street
HEINTZ, JOHN C.....	169th Street and Third Avenue
HENRIQUES, DR. H. A.....	Morristown, N. J.
HERMANN, FERDINAND.....	P. O. Box 477, New York
HERTER, DR. CHRISTIAN A.....	819 Madison Avenue
HESS, SELMAR.....	956 Madison Avenue
HEITEMEYER, CLEMENS.....	810 Hudson Street, Hoboken, N. J.
HILL, E. B.....	11 Sumner Street, Quincy, Mass.
HILL, NICHOLAS S., JR.....	243 West 98th Street
HILYARD, GEORGE D.....	144 East 49th Street
HINES, GARFIELD.....	126 Liberty Street
HINTON, DR. JOHN H.....	41 West 32d Street
HITCHCOCK, CENTER.....	Knickerbocker Club
HOAGLAND, MISS FANNY M.....	27 West 51st Street
HOE, RICHARD M.....	11 East 71st Street
HOE, MRS. RICHARD M.....	11 East 71st Street
HOE, MRS. ROBERT.....	11 East 36th Street
HOLBROOK, MRS. F. S.....	Stamford, Conn.
HOLBROOK, MISS LILIAN.....	Stamford, Conn.
HOLDEN, EDWIN B.....	323 Riverside Drive
HOLDEN, GEORGE A.....	185 Riverside Drive
HOLLAND, HEDLEY L.....	2244 Bathgate Avenue, New York
HOLLISTER, GEORGE CLAY.....	515 Madison Avenue
HOLST, L. J. R.....	1410 President Street, Brooklyn, N. Y.
HOLT, HENRY.....	29 West 23d Street
HOMER, WALLACE.....	Garrison, N. Y.
HOPPIN, HAMILTON L.....	Mt. Kisco, N. Y.
HOPPIN, SAMUEL HOWLAND.....	55 Liberty Street
*HORTON, G. B.	
HOSKIER, H. C.....	49 Wall Street
HOWLAND, G. G.....	37 East 35th Street
HOWLAND, HENRY E.....	35 Wall Street
HOYT, ALFRED M.....	1 Broadway
HOYT, COLGATE.....	36 Wall Street
HOYT, GEORGE S.....	72 Gold Street
HUMPHREYS, MRS. EDWARD WALSH.....	32 East 38th Street
HUNTINGTON, REV. W. R.....	804 Broadway
HUSSEY, WILLIAM H.....	142 Arlington Avenue, East Orange, N. J.

\*Deceased.

HUTCHINS, AUGUSTUS SCHELL.....	69 Wall Street
HYDE, B. T. BABBITT.....	20 West 53d Street
HYDE, CLARENCE M.....	80 Broadway
HYDE, DR. FREDERICK E.....	20 West 53d Street
INCHES, GEORGE B.....	North Grafton, Worcester Co., Mass.
INNESS, GEORGE, JR.....	145 West 58th Street
INSLEE, MRS. HELEN C.....	50 West 72d Street
ISELIN, ADRIAN, JR.....	9 East 26th Street
ISHAM, CHARLES H.....	30 East 63d Street
ISHAM, MISS JULIA B.....	5 East 61st Street
ISHAM, SAMUEL.....	5 East 61st Street
ITTNER, J. J.....	813 Park Avenue
JACKSON, FREDERIC WENDELL.....	Westchester, New York City
JACKSON, DR. GEORGE THOMAS.....	692 West End Avenue
JACKSON, J. A.....	Box 86, Springdale, Conn.
JACKSON, R. G.....	23 Cedar Place, Yonkers, N. Y.
JACKSON, SAMUEL MACAULEY.....	692 West End Avenue
JACKSON, THEODORE F.....	10 West 43d Street
JACOB, CHARLES.....	310 West 45th Street
JACOB, LAWRENCE.....	42 East 49th Street
JACOBI, DR. A.....	19 East 47th Street
JACOBUS, JOHN S.....	107 East 37th Street
JACQUELIN, HERBERT T. B.....	34 East 38th Street
JACQUELIN, JOHN H.....	34 East 38th Street
JAMES, ARTHUR CURTISS.....	99 John Street
JAMES, DR. ROBERT C.....	58 West 55th Street
JAMES, DR. WALTER B.....	17 West 54th Street
JAMES, NORMAN.....	Baltimore, Md.
JEIDELL, HUGH.....	407 West 148th Street
JENNINGS, F. B.....	86 Park Avenue
JENNINGS, PHILANDER R.....	190 Water Street
JENNINGS, WALTER.....	26 Broadway
JESUP, CHARLES M.....	124 East 36th Street
JEWETT, C. H., JR.....	South Orange, N. J.
JEWETT, GEORGE W.....	20 Broad Street, South Orange, N. J.
JOHNSON, MRS. F. COIT.....	Weekapaug Inn, Weekapaug, R. I.
JOHNSON, DAVID S.....	72 East 127th Street
JOHNSTON, THEODORE V., JR.....	234 Central Park West
JOLINE, ADRIAN HOFFMAN.....	1 West 72d Street
JONES, H. BOLTON.....	253 West 42d Street
JONES, MRS. JOHN D.....	Fifth Avenue Hotel
JONES, LEWIS Q.....	Bay View, Newport, R. I.
KAHN, LOUIS.....	172 Broadway
KAHN, MOSES.....	172 Broadway
KANE, JOHN INNES.....	49 West 23d Street
KANE, S. NICHOLSON.....	23 West 47th Street
KARATSONYI, MARTIN.....	Glenwood, L. I.
KEECH, FRANK B.....	14 East 65th Street
KEIL, WILL. M.....	Tuxedo Park, N. Y.
KEITH, D. E.....	115 West 125th Street
KELLEY, AUSTIN P.....	37 Wall Street
KELLY, EUGENE.....	763 Fifth Avenue
KELLY, PATRICK.....	Kingsbridge Road and Taylor Avenue
KEMP, ARTHUR T.....	615 Fifth Avenue
KENT, EDWIN C.....	80 William Street
KENYON, ROBERT N.....	49 Wall Street
KEUFFEL, WILHELM.....	510 Hudson Street, Hoboken, N. J.
KIDDER, JAMES HATHAWAY.....	Union Club, Boston, Mass.
KIMBALL, ALFRED R.....	15 Wall Street



KING, RUPERT COCHRANE.....	27	Waverley Place
KING, WILLIAM F.....	871	Madison Avenue
KING, WILLIAM W.....	N. & S. R. R.,	Norfolk, Va.
KIP, IRA A., JR.....		South Orange, N. J.
KIPP, FRANK A.....		Pelham Avenue and Southern Boulevard
KLEE, BENJAMIN.....	22	Lafayette Place
KNAPP, DR. HERMAN.....	26	West 40th Street
KNAPP, JOHN M.....	66	Broadway
KNOEDLER, ROLAND F.....	122	West 13th Street
KNOX, JAMES W.....	2032	Bathgate Avenue
KOBBE, LIEUT. FERDINAND W.....		Philippine Islands
KOHLMAN, CHARLES.....	1007	Madison Avenue
KRAUS, DANIEL.....	1037	East 183d Street
KRETZ, HOWARD C.....	2441	Seventh Avenue
KUHN, GEORGE J.....	4400	Park Avenue
KUHNE, PERCIVAL.....	7	East 78th Street
KUNHARDT, HENRY R.....	124	West 74th Street
KUTTROFF, ADOLF.....	17	East 69th Street
LA FARGE, OLIVER H. P.....		Second Avenue and Cherry Street, Seattle, Wash.
LAGAI, DR. GEORGE.....	225	Fourth Avenue
LAMBERT, DR. ALEXANDER.....	125	East 36th Street
LANDON, FRANCIS G.....	29	Broadway
LANE, EDWARD V. Z.....	143	Liberty Street
LANE, JAMES WARREN.....	4	East 61st Street
LANGE, J. D.....	220	West 79th Street
LANGLOTH, J.....	784	Fifth Avenue
LANGMANN, DR. GUSTAV.....	121	West 57th Street
LAPSLEY, DAVID.....	44	West 33d Street
LATHROP, FRANCIS.....	29	Washington Square
LAUDAUER, I. N.....	37	East 76th Street
LAWRENCE, CYRUS J.....	81	Park Avenue
LAWRENCE, JOHN BURLING.....	126	East 30th Street
LAWRENCE, NEVBOLD T.....	51	Liberty Street
LAWRENCE, TOWNSEND.....		Willow Bank, Flushing, L. I.
LAWRENCE, WALTER BOWEN.....		Lawrence Street, Flushing, L. I.
LAWRENCE, W. V.....	542	Fifth Avenue
LAYNG, J. D.....		Mt. Kisco, N. Y.
LEDoux, ALBERT R.....	39	West 50th Street
LEE, PROF. FREDERIC S.....	64	Park Avenue
LEE, MRS. FREDERIC S.....	64	Park Avenue
LEE, J. BOWERS.....	51	Exchange Place
LEFFERTS, MARSHALL C.....	34	East 65th Street
LE GENDRE, WILLIAM C.....	59	Wall Street
LEIGHTON, ROBERT E.....	126	Liberty Street
LEITNER, JACOB.....	678	Union Avenue
LEITNER, JOSEPH.....	938	East 183d Street
LE ROY, ALFRED.....	117	Wall Street
LESHER, A. L.....	9	East 75th Street
LETKEMANN, H. V.....	1278	Fulton Avenue
LEVY, EMANUEL.....	280	Pearl Street
LEWIS, FREDERIC ELLIOTT.....	Box 572,	Tarrytown, N. Y.
LEWIS, MISS MARGUERITE.....	215	Madison Avenue
LEWIS, PERCY PYNE.....	15	West 42d Street
LEWIS, DR. WILLIAM J.....	319	West 116th Street
LEWISOHN, ADOLPH.....	11	Broadway
LIBBEY, O. B.....		Hotel Albemarle, Madison Square
LIEBENAU, ALBERT.....	3492	Park Avenue
LIEBERTZ, JOSEPH.....	1018	Prospect Avenue
LIPPMANN, DANIEL J.....	1974	Bathgate Avenue

LITCHFIELD, EDWARD H.....	59 Wall Street
LIVERMORE, JOHN R.....	36 West 46th Street
LIVINGSTON, THOMAS G.....	Boston Road, Bronxdale
LIVINGSTON, WILLIAM S.....	207 Berry Street, Brooklyn
LOBENSTINE, WILLIAM CHRISTIAN.....	245 Central Park West
LOCKWOOD, WILLISTON B.....	205 West 57th Street
LOEBER, CHARLES.....	Bedford Park, N. Y.
LOGAN, WALTER S.....	114 Riverside Drive
LONGENECKER, CHARLES.....	126 Liberty Street
LONGFELLOW, MRS. FREDERICK W.....	Riverdale-on-Hudson
LORING, J. ALDEN.....	Owego, N. Y.
LOWELL, MRS. CHARLES RUSSELL.....	120 East 30th Street
LUCKSINGER, JACQUES.....	East 198th Street and Pond Place
LUD, DUDLEY OLCOTT.....	4 East 53d Street
LUDEWIG, CHARLES H.....	996 Tremont Avenue
LUEDER, A.....	112 Wall Street
LUND, MRS. F. A.....	512 Madison Avenue
LUSK, PROF. GRAHAM.....	11 East 74th Street
LUTTGEN, WALTHER.....	P. O. Box 1587, New York City
LYMAN, FRANK.....	34 Remsen Street, Brooklyn
LYNDE, FRANCIS E. P.....	318 West 86th Street
MCALAN, JOHN.....	4 West 84th Street
MCALPIN, CHARLES W.....	10 West 43d Street
MCALPIN, MRS. CHARLES W.....	10 West 43d Street
MCALPIN, GEORGE L.....	52 East 55th Street
MCCALL, JOHN A.....	346 Broadway
MCCLURE, S. S.....	141 East 25th Street
MCCURDY, RICHARD A.....	(Personal) 32 Liberty Street
McKAY, THOMAS.....	460 East 10th Street
MACKAYE, BENTON.....	51 East 25th Street
McKIM, REV. HASLETT.....	9 West 48th Street
McKIM, JOHN A.....	18 Wall Street
McLANE, GUY RICHARDS.....	51 West 38th Street
McLAUGHLIN, A. P.....	1028 Grote Street
McLEAN, JAMES.....	16 West 55th Street
McLENNAN, CHARLES A.....	Whatcom, Wash.
McVICKAR, EDWARD.....	112 East 56th Street
MACE, ARTHUR J.....	Williamsbridge, N. Y.
MACKAY, GEORGE D.....	20 West 69th Street
MAGEE, JOHN.....	Corning, N. Y.
MAGER, F. ROBERT.....	423 West 147th Street
MAHER, JAMES H.....	500 Fifth Avenue
MAHL, WILLIAM.....	200 West 138th Street
MALI, PIERRE.....	8 Fifth Avenue
MAPES, DANIEL, JR.....	1920 West Farms Road
MAPES, ERNEST S.....	1279 East 176th Street
MARLOR, HENRY S.....	Brooklyn, Conn.
MARSH, C. P.....	Country Club, Westchester
MARSHALL, LOUIS.....	33 East 72d Street
MARTIN, GEORGE C.....	106 West 61st Street
MARSTON, EDWIN S.....	291 Clinton Avenue, Brooklyn
MARTIN, F. E.....	44 Pine Street
MASLEN, RICHARD R.....	217 West 125th Street
MATHEWS, THOMAS.....	110 Wall Street
MATTHEWS, JOHN H.....	90th Street and Riverside Drive
MAXWELL, ROBERT.....	817 Broadway
MAYER, ALFRED G....	Museum of B'klyn Institute, Eastern Parkway, B'klyn
MEHL, HENRY.....	128 Webster Avenue, Jersey City, N. J.
MERKEL, HERMANN W.....	New York Zoological Park

MERZ, PHILIPP.....	36 West 93d Street
MEYER, HERMANN N.....	4532 Park Avenue
MEYROWITZ, EMIL B.....	104 East 23d Street
MIDDLEBROOK, FREDERICK.....	Grand Central Station
DE MILHAU, LOUIS JOHN.....	Harvard University, Cambridge, Mass.
MILES, JOHN.....	610 Broadway
MILLER, EDWARD F.....	712 Tremont Avenue
MILLER, FRANK C.....	900 Sixth Avenue
MILLER, WILLIAM R.....	Southern Boulevard and 187th Street
MILLS, ABRAHAM G.....	71 Broadway
MILLS, W. McMASTER.....	65 East 55th Street
MINOTT, W. A.....	South Orange, N. J.
MITCHELL H. RAYMOND.....	2849 Briggs Avenue, Bronx
MOENCH, HUGO.....	133 East 23d Street
MOLERA, E. J.....	2025 Sacramento Street, San Francisco, Cal.
MONTANT, ALPHONSE.....	326 West 22d Street
MONTGOMERY, RICHARD M.....	19 West 34th Street
MOORE, CASIMIR DE R.....	109 East 38th Street
MOORE, CHARLES ARTHUR, JR.....	277 Madison Avenue
MOORE, FRANCIS C.....	80 Madison Avenue
MORGAN, MISS ANNIE T.....	219 Madison Avenue
MORGAN, MISS C. L.....	121 Madison Avenue
MORGAN, EDWIN D.....	100 Broadway
MORGAN, GEORGE H.....	6 East 40th Street
MORGAN, J. P., JR.....	J. S. Morgan & Co., London, England
MORGAN, JUNIUS S.....	Princeton, N. J.
MORGAN, MRS. JUNIUS S.....	Princeton, N. J.
MORRELL, MRS. ROBERT LEE.....	2 East 45th Street
MORRIS, DAVE H.....	Westchester, New York City
MORRIS, FORDHAM.....	16 Exchange Place
MORRIS, DR. LEWIS R.....	60 West 58th Street
MOTT, HENRY C.....	428 Grand Avenue, Brooklyn, N. Y.
MOTT, JORDAN L., JR.....	17 East 47th Street
MOTT, J. L. B.....	Bellport, L. I.
MUELLER, CHARLES F.....	1815 Prospect Avenue
MUNN, HENRY NORCROSS.....	Orange, N. J.
MUNROE, HENRY W.....	32 Nassau Street
MURGATROYD, JOHN.....	128 St. James Place, Brooklyn
MURKEN, WILLIAM H.....	3 York Terrace, New Brighton, S. I.
MURRAY, A. S.....	10 West 11th Street
MURTHA, JAMES J.....	339 Alexander Avenue
NEFF, LOUIS.....	155 Ainslie Street, Brooklyn, N. Y.
NEILSON, DR. HOWARD S.....	P. O. Box 234, Althea Farm, Darien, Conn.
NESBITT, A. G.....	Kingston, Pa.
NICHOLS, ACOSTA.....	54 William Street
NICHOLS, GEORGE L.....	66 East 56th Street
NILES, J. BARRON.....	Bedford Park
NILES, ROBERT L.....	20 Broad Street
NOBLE, H. G. S.....	30 Broad Street
NORRIE, A. LANFEAR.....	15 East 84th Street
NOTMAN, JOHN.....	54 Wall Street
OAKLEY, H. CRUGER.....	52 Broadway
O'CONNELL, MICHAEL.....	2075 Arthur Avenue
O'CONNOR, ISAAC.....	126 Liberty Street
OELRICHS, HERMANN, JR.....	1 East 57th Street
OGDEN, M. C.....	38 Munroe Place, Brooklyn
OLSEN, CHARLES P.....	2796 Pond Place
OLYPHANT, ROBERT.....	21 Cortlandt Street
OLYPHANT, R. M.....	21 Cortlandt Street

ONATIVIA, JOHN VICTOR.....	16 East 82d Street
OSBORN, MRS. HENRY F.....	850 Madison Avenue
OSTRANDER, MISS MARY M.....	50 West 53d Street
OTTEN, MRS. GERTRUDE.....	76 William Street
OUTERBRIDGE, DR. PAUL.....	27 West 74th Street
OVENS, JAMES.....	770 Tremont Avenue
OWEN, MISS JULIETTE A.....	306 North 9th Street, St. Joseph, Mo.
PALMER, FRANCIS F.....	922 Fifth Avenue
PALMER, NICHOLAS F.....	922 Fifth Avenue
PALMER, S. S.....	52 Wall Street
PANCOAST, RICHARD.....	28 Platt Street
PARKER, FRANCIS EYRE.....	160 West 59th Street
PARSONS, EDWIN.....	958 Madison Avenue
PARSONS, MRS. EDWIN.....	326 West 90th Street
PARSONS, JOHN E.....	30 East 36th Street
PARSONS, H. DE B.....	22 William Street
PARSONS, WILLIAM BARCLAY.....	320 Broadway
PARSONS, WILLIAM BARCLAY, JR.....	51 East 53d Street
PARSONS, WILLIAM H.....	Rye, N. Y.
PATERSON, R. W.....	2 West 51st Street
PATTERSON, MISS ELEANOR S.....	19 East 45th Street
PAUL, W. A. O.....	Hotel Margaret, Brooklyn
PEABODY, ROYAL C.....	11 Broadway
PEARSON, EDWIN RICHTER.....	P. O. Box 721, Schenectady, N. Y.
PEEK, HENRY T.....	1820 Monroe Avenue
PELL, MRS. ALFRED.....	Highland Falls, N. Y.
PELL, STEPHEN H. P.....	7 Wall Street
PELTON, FRANKLIN D.....	Calumet Club
PENDLETON, FRANCIS KEY.....	7 East 86th Street
PENFOLD, WILLIAM HALL.....	10 East 40th Street
PENNIMAN, GEORGE H.....	1071 Fifth Avenue
PERKINS, ROBERT P.....	3 West 16th Street
PERRY, CHARLES J.....	Astor House, New York City
PETERS, CHARLES G.....	38 East 50th Street
PETERS, DR. JULIUS.....	937a Summit Avenue, Jersey City
PETERS, SAMUEL T.....	117 East 37th Street
PETERS, W. R.....	23 West 73d Street
PHYFE, W. H. P.....	12 East 43d Street
PICKHARDT, CARL.....	1042 Madison Avenue
PIEL, GOTTFRIED.....	Liberty and Sheffield Avenues, Brooklyn
PIERCE, HENRY CLAY.....	Waldorf-Astoria
PIERSON, GEN. J. FRED.....	20 West 52d Street
PINCHOT, GIFFORD.....	Department of Agriculture, Washington, D. C.
PLYMPTON, GILBERT M.....	30 West 52d Street
POGGENBERG, H. F.....	115 East 69th Street
POLAND, SAMUEL.....	667 Eighth Avenue
POLLOCK, GEORGE E.....	28 West 21st Street
PORTER, CLARENCE.....	83 Park Avenue
PORTER, WILLIAM L.....	P. O. Box 573, Watford, N. Y.
POST, ABRAHAM S.....	81 Fulton Street
POST, EDWARD C.....	350 West End Avenue
POST, GEORGE B., JR.....	38 Wall Street
POSTLEY, CLARENCE A.....	817 Fifth Avenue
PÖTTER, MISS BLANCHE.....	33 East 38th Street
POTTER, E. C.....	36 Wall Street
POTTER, FREDERICK.....	71 Broadway
POTTER, MISS MARTHA.....	33 East 38th Street
POTTS, WILLIAM BREVOORT.....	127 East 55th Street
PRENTICE, JOHN H.....	3 West 37th Street

PRENTISS, GEORGE LEWIS.....	University Club
PRINCE, EDWARD S.....	2055 Bathgate Avenue
PRINCE, PROF. J. DYNELEY.....	University Heights
PRYER, CHARLES.....	New Rochelle, N. Y.
PUTNAM, R. M. S.....	318 West 84th Street
PUTNAM, WILLIAM A.....	2 Wall Street
PYLE, JAMES TOLMAN.....	673 Fifth Avenue
PYNE, M. TAYLOR.....	52 Wall Street
PYNE, MRS. M. TAYLOR.....	263 Madison Avenue
QUINTARD, EDWARD.....	145 West 58th Street
RAND, GEORGE C.....	Lawrence, L. I.
RANDOLPH, L. V. F.....	60 Broadway
RANDOLPH, WILLIAM W.....	31 Nassau Street
RATHBORNE, RICHARD C.....	Care Spratt's Patent (Ltd.), Newark, N. J.
RAUCH, WILLIAM.....	Union Club
READ, WILLIAM A.....	4 East 62d Street
REDMOND, HENRY S.....	41 Wall Street
REDMOND, GOULD H.....	6 North Washington Square
REIMER, OTTO E.....	15 Broad Street
REINHARDT, GEORGE N.....	1346 Franklin Avenue
REYNOLDS, E. B.....	281 Decatur Street, Brooklyn
REYNOLDS, JAMES BRONSON.....	7 West 43d Street
RHEINELANDER, CHARLES E.....	6 West 32d Street
RHOADES, JOHN HARSEN.....	559 Madison Avenue
RICHARD, AUGUSTE.....	12 East 69th Street
RICHARDS, E. O.....	105 East 19th Street
RIKER, JOHN L.....	19 West 57th Street
RIKER, SAMUEL.....	27 East 69th Street
RIPLEY, H. DILLON.....	Racquet Club
RIPLEY, SIDNEY DILLON.....	Hempstead, L. I.
RIVES, GEORGE L.....	32 Nassau Street
ROBBINS, CHANDLER.....	64 West 47th Street
ROBERTSON, MRS. F. P.....	2069 Fifth Avenue
ROBISON, WILLIAM.....	18 Wall Street
ROCKWOOD, WILLIAM H.....	513 West End Avenue
ROE, FRANK O.....	3 East 83d Street
ROE, IRVING L.....	174 West 72d Street
ROELKER, ALFRED.....	53 West 47th Street
ROGGENKAMP, AUGUST.....	567 East 176th Street
ROGERS, E. L.....	71 Broadway
ROGERS, JAMES H.....	1 Wall Street
ROKENBAUGH, HENRY S.....	100 Broadway
ROOSEVELT, W. EMLIN.....	804 Fifth Avenue
ROOT, ELIHU.....	Room 64, The Arlington, Washington, D. C.
ROPES, ALBERT G.....	17 State Street
ROSE, JOHN J.....	Jerome Street, Williamsbridge, N. Y.
ROSS, P. SANFORD.....	29 Maiden Lane
ROSSITER, E. V. W.....	Sanford Avenue, Flushing, L. I.
ROTH, F. R. G.....	571 Fifth Avenue
RUNGUIS, CARL.....	107 Kent Street, Brooklyn
RUNYON, CHARLES.....	25 Fifth Avenue
RUPPERT, JACOB.....	1116 Fifth Avenue
RUSS, WILLIAM V.....	209 North 6th Street, Roseville, Newark, N. J.
RUSSELL, ROBERT HOWARD.....	Union Club
RYAN, J. D.....	825 Third Avenue
SACKETT, MISS.....	196 Madison Avenue
SACKETT, CLARENCE.....	196 Madison Avenue
SACKETT, MRS. S. E.....	196 Madison Avenue
SAGE, JOHN H.....	Portland, Conn.

SAGE, MRS. RUSSELL.....	509 Fifth Avenue
SAMPSON, ALDEN.....	Haverford, Pa.
SANDERSON, LLOYD BOWEN.....	22 State Street
SAUSE, RICHARD E.....	725 Sixth Avenue
SAUTER, FREDERICK.....	3 North William Street
SCHARMANN, H. B.....	170 West 59th Street
SCHEFER, CARL.....	40 West 37th Street
SCHIEFFELIN, WILLIAM J.....	5 East 66th Street
SCHILLING, R. H.....	28 Cooper Square
SCHIRMER, GUSTAV.....	117 East 35th Street
SCHIRMER, RUDOLPH E.....	243 East 17th Street
SCHNEIDER, G. E.....	961 East 184th Street
SCHOLL, JULIAN.....	126 Liberty Street
SCHOLLE, A. H.....	30 Broad Street
SCHUCHARD, E. W.....	Manhasset, L. I.
SCHULTZE, JOHN S.....	59 Wall Street
SCHUMACHER, C.....	31 East 81st Street
SCHUYLER, MISS LOUISA LEE.....	135 East 21st Street
SCHWAB, MRS. GUSTAV.....	Morris Heights
SCHWARZ, HENRY F.....	39 West 23d Street
SCHWEIZER, J.....	2151 Prospect Avenue
SCOTT, WILLIAM.....	33 West 63d Street
SEARS, ROBERT B.....	7 Taulmier Place, Jersey City
SEIB, HENRY.....	174 West 141st Street
SELIGMAN, ALFRED L.....	Mills Building
SHAPIRO, D.....	4175 Third Avenue
SHAW, CHARLES HERBERT.....	47 West 43d Street
SHAW, JAMES G.....	130 William Street
SHAW, WALTER W.....	11 West 52d Street
SHELDON, GEORGE R.....	24 East 38th Street
SHELDON, MRS. ISAAC E.....	83 East 56th Street
SHELDON, WILLIAM C.....	95 Park Avenue
SHERMAN, GARDINER.....	Metropolitan Club
SHIPWAY, JOHN H.....	2972 Hull Avenue, Bedford Park
SHRADY, HENRY M.....	305 West 80th Street
SHURTLEFF, R. M.....	44 West 22d Street
SIEGEL, JACOB.....	169th Street and Third Avenue
SILLIMAN, HARPER.....	562 Fifth Avenue
SIMMONS, JOSEPH F.....	28 West 52d Street
SIMONS, JAMES D.....	44 Broad Street
SIMPSON, WILLIAM.....	757 Sixth Avenue
SKEEL, FRANK D.....	361 Mott Avenue
SKIDMORE, WILLIAM L.....	39 West 52d Street
SMILEY, DANIEL.....	Mohonk Lake, N. Y.
SMILLIE, CHARLES F.....	50 Wall Street
SMITH, AUGUSTINE J.....	329 Lexington Avenue
SMITH, F. M.....	101 Sansome Street, San Francisco, Cal.
SMITH, GEORGE WARREN.....	Metropolitan Club
SMITH, LUCIUS H.....	19 East 34th Street
SMITH, PHILIP S.....	264 Summer Street, Buffalo, N. Y.
SMITH, ROBERT W.....	201 East 12th Street
SMITH, WILLIAM ALEXANDER.....	412 Madison Avenue
SMITHERS, CHARLES.....	507 Madison Avenue
SMITHERS, F. S.....	180 West 59th Street
SMYTH, PHILIP A.....	57 East 127th Street
SNEAD, C. S.....	Room 1115, 21 State Street
SOLTMANN, E. G.....	Bedford Park
SOTSCHACK, CARL.....	1773 Clay Avenue
SOUTHACK, FREDERICK.....	48 West 53d Street

SOUTHARD, GEORGE H.....	164 Montague Street, Brooklyn
SPEIR, MRS. CECILIA M.....	South Orange, N. J.
SPENCER, SAMUEL.....	80 Broadway
SPIEGELBERG, F.....	19 William Street
SPITZNER, GEORGE W.....	12 East 74th Street
SPOFFORD, MRS. J. L.....	Hunts Point, N. Y.
SPRING, MISS ANNA RIKER.....	434 Madison Avenue
SPRINGMEYER, ALBERT A.....	120 Broadway
SPURR, E. W.....	110 Worth Street
SQUIBB, CHARLES F.....	Bernardsville, N. J.
SQUIBB, DR. EDWARD H.....	148 Columbia Heights, Brooklyn
STANTON, JOHN.....	13 William Street
STANTON, JOHN R.....	256 West 70th Street
STARR, LOUIS MORRIS.....	3 West 53d Street
STEBBINS, JAMES H.....	80 Madison Avenue
STEEVES, JOHN F.....	138th Street and Fourth Avenue
STEINBECK, EDWARD.....	Prospect Avenue and 180th Street
STEPHENS, OLIN J.....	146th Street and Gerard Avenue
STERN, ISAAC.....	32 West 23d Street
STERN, MRS. EMIL.....	410 West 154th Street
STERNBACH, CHARLES.....	129 East 69th Street
STEVENS, FREDERIC W.....	33 West 35th Street
STEWART, WILLIAM R.....	31 Nassau Street
STILLMAN, JAMES A.....	7 East 40th Street
STIMSON, DR. DANIEL M.....	11 West 17th Street
STOKES, H. B.....	New Rochelle, N. Y.
STOKES, J. G. PHELPS.....	229 Madison Avenue
STONE, MASON A.....	244 Central Park West
STOUT, JOSEPH S., JR.....	25 Broad Street
STOW, GEORGE G.....	Oyster Bay, L. I.
STRANGE, A. B.....	Woodmere, L. I.
STRATFORD, PROF. WILLIAM.....	263 West 52d Street
STREAT, JAMES.....	62 Leonard Street
STREETER, D. D., JR.....	113 Hooper Street, Brooklyn
STUART, INGLIS.....	29 Broadway
STURGES, HENRY C.....	56 East 34th Street
STUYVESANT, RUTHERFURD.....	18 Exchange Place
SULLIVAN, MRS. JAMES.....	36 Park Avenue
SUSSER, JOHN M.....	183d Street and Third Avenue
SUTPHEN, JOHN S., JR.....	9 Desbrosses Street
SUYDAM, HARRY L.....	530 Broadway
SWAYNE, FRANCIS B.....	Riverside Avenue and 90th Street
SYMS, DR. PARKER.....	50 West 47th Street
TABER, MISS MARY.....	9 East 10th Street
TAFT, HENRY W.....	40 Wall Street
TALCOTT, JAMES.....	7 West 57th Street
TATHAM, CHARLES.....	405 West 23d Street
TAYLOR, DWIGHT W.....	500 Madison Avenue
TAYLOR, GEORGE.....	8 West 126th Street
TAYLOR, HENRY R.....	40 Wall Street
TAYLOR, HERBERT C.....	52 Broadway
TAYLOR, JAMES B.....	10 Wall Street
TAYLOR, KNOX.....	Highbridge, N. J.
TAYLOR, LLOYD.....	29 Broadway
TAYLOR, MOSES.....	100 Broadway
*TEFFT, WILLIAM E.....	
TENNEY, C. H.....	Metropolitan Club
TERRY, JOHN T.....	Tarrytown, N. Y.

\*Deceased.

TERRY, REV. RODERICK.....	169	Madison Avenue
TESLA, NIKOLA.....		Tesla Laboratory, Wardenclyffe, L. I.
THACHER, MRS. GEORGE W.....		Care Charles A. Peabody, 2 Wall Street
THACHER, THOMAS.....	25	Broad Street
THAYER, HARRY BATES.....	463	West Street
THOMAS, DR. ALLEN M.....	45	West 54th Street
THOMAS, SETH E.....	8	West 20th Street
THOMPSON, PROF. W. GILMAN.....	34	East 31st Street
THOMSON, DAVID.....	14	East 73d Street
THORNE, NEWBERRY D.....		New Rochelle, N. Y.
THORNE, W. V. S.....	120	Broadway
TIBBITS, LE GRAND C.....		Hoosac, N. Y.
TIFFANY, LOUIS C.....	27	East 72d Street
TILFORD, HENRY M.....	24	West 52d Street
*TILLINGHAST, WILLIAM H.....		
TILTON, JOSEPH W.....	11	Broadway
TOD, J. KENNEDY.....	45	Wall Street
TODD, H. H.....		New Rochelle, N. Y.
TOEL, WILLIAM.....	20	East 67th Street
*TOOTHE, WILLIAM.....		
TOUSEY, WILLIAM.....	14	East 46th Street
TOWNSEND, CHARLES H.....		Aquarium, Battery Park
TOWNSEND, ISAAC.....		Union Club
TOWNSHEND, JOHN.....	302	West 73d Street
TOWS, COE DOWNING.....	34	West 52d Street
TRABER, A. P.....	2151	Prospect Avenue
TRASK, SPENCER.....	52	William Street
TROWBRIDGE, EDWIN D.....	123	East 39th Street
TROWBRIDGE, FREDERICK K.....	115	East 37th Street
TRUAX, HON. CHARLES H.....	12	East 65th Street
TUCKERMAN, ALFRED.....	342	West 57th Street
*TURNBULL, ROBERT J.....		
TURNURE, GEO. E.....	115	East 36th Street
TWEDDELL, WILLIAM H.....	237	Prospect Street, South Orange, N. J.
UNDERWOOD, WILLIAM LYMAN.....		Belmont, Mass.
UPMANN, CARL.....	406	East 59th Street
VALENTINE, DR. WILLIAM A.....	34	West 38th Street
VAN BRUNT, HON. C. H.....	10	East 46th Street
VAN CORTLANDT, AUGUSTUS.....		Bartow
VANDERPOEL, MRS. JOHN A.....	723	Park Avenue
VAN DER SMISSEN, DR. G. J.....	2081	Bathgate Avenue
VAN DER SMISSEN, GILBERT.....	758	Tremont Avenue
VAN EMBURGH, D. B.....	30	East 38th Street
VAN NEST, MRS. ALEXANDER T.....	31	West 37th Street
VAN NEST, G. WILLETT.....	14	East 60th Street
VAN NORDEN, WARNER.....	751	Fifth Avenue
VAN PELT, GILBERT S.....	123	East 69th Street
VAN WINKLE, EDGAR B.....	115	East 70th Street
*VAN WINKLE, GEORGE S.....		
VERDI, MISS MARY.....	14	Fifth Avenue
VIELE, HERMAN K.....	146	East 35th Street
VIVANTI, FERRUCCIO ANSELMOL.....	995	Madison Avenue
VOGEL, HERMAN.....	106	East 37th Street
VOGEL, JOHN.....	1105	East 178th Street
VORCE, A. D.....	353	Fifth Avenue
WADSWORTH, CLARENCE S.....		Middletown, Conn.
WADSWORTH, W. P.....	25	East 30th Street
WAGNER, OTTO.....		Washington Avenue and 185th Street

\*Deceased.



WAGSTAFF, C. DU BOIS.....	Babylon, L. I.
WALKER, GEORGE L.....	560 West 149th Street
WALKER, GEORGE W.....	560 West 149th Street
WALLER, ROBERT, JR.....	25 Broad Street
WALTER, HENRY.....	76 Forsyth Street
WALTON, WILLIAM.....	360 West 22d Street
WANNINGER, CHARLES.....	114 East 95th Street
WARD, HENRY C.....	431 Fifth Avenue
WARD, J. Q. A.....	119 West 52d Street
WARDWELL, WILLIAM T.....	21 West 58th Street
WATERBURY, JOHN I.....	20 Wall Street
WATSON, CHARLES F.....	South Orange, N. J.
WATSON, REV. J. HENRY.....	51 West 75th Street
WEATHERBEE, EDWIN H.....	240 Madison Avenue
WEBB, G. CREIGHTON.....	47 East 44th Street
WEBB, DR. W. SEWARD.....	51 East 44th Street
WEBER, LOUIS.....	9 East 93d Street
WELLING, R. W. G.....	2 Wall Street
WELLS, OLIVER J.....	Waldorf-Astoria
WENDELL, EVERT JANSEN.....	8 East 38th Street
WENDELL, MRS. JACOB.....	8 East 38th Street
WENZEL, LOUIS H.....	133 West 83d Street
WERTHEIM, H. P.....	27 William Street
WESTERGREN, M. F.....	433 East 144th Street
WESTOVER, M. F.....	Schenectady, N. Y.
WHITAKER, H. P.....	Hotel Netherlands
WHITE, ALAIN C.....	560 Fifth Avenue
WHITE, JOHN JAY, JR.....	103 East 57th Street
WHITE, LEONARD D.....	45 West 75th Street
WHITE, STANFORD.....	160 Fifth Avenue
WHITE, S. V.....	66 Broadway
WHITE, WILLIAM W.....	49 Broad Street
WHITEHOUSE, J. HENRY.....	Irvington-on-Hudson
WHITEHOUSE, WILLIAM F.....	Knickerbocker Club
WHITFIELD, HENRY D.....	14 East 11th Street
WHITING, GILES.....	898 Broadway
WHITING, MISS GERTRUDE.....	1 West 94th Street
WHITMAN, CLARENCE.....	P. O. Box 1805, New York City
WHITNEY, CASPAR.....	3 Washington Square North
WHITNEY, MISS E. C.....	11 North Madison Square
WHITRIDGE, F. W.....	59 Wall Street
WICKERSHAM, GEORGE W.....	40 Wall Street
WIEGMANN, DR. WILLIAM H.....	416 Sixth Street
WIGGIN, FREDERICK HOLME.....	55 West 36th Street
WILLARD, E. A.....	21 State Street
WILLETS, ROBERT R.....	303 Pearl Street
*WILLIAMS, G. G.....	
WILLS, CHARLES T.....	156 Fifth Avenue
WILMERDING, GUSTAV L.....	38 Nassau Street
WILMSEN, WILLIAM.....	414 Lenox Avenue
WILSON, HENRY R.....	208 Fifth Avenue
WILSON, WILLIAM.....	Briggs Avenue, near 201st Street
WINCKELBACH, L. O.....	854 West End Avenue
WINTHROP, EGERTON L.....	23 East 33d Street
WINTHROP, ROBERT D.....	P. O. Box 17, New York City
WITHERBEE, FRANK S.....	71 Broadway
WITTE, C. W.....	747 Tremont Avenue
WOLFF, EMIL.....	115 West 70th Street

\*Deceased.

WOOD, GILBERT CONGDON.....	51 Fifth Avenue
WOOD, J. WALTER, JR.....	Short Hills, N. J.
WOOD, WILLIAM C.....	51 Fifth Avenue
WOOD, WILLIAM H. S.....	51 Fifth Avenue
WOODCOCK, R. C.....	636 West 55th Street
WOODHOUSE, J. S.....	341 West 87th Street
WRIGHT, J. DUNBAR.....	346 Lexington Avenue
WRIGHT, JOHN HOWARD.....	2 Wall Street
WRIGHT, MRS. J. HOOD.....	Kingsbridge Road and 174th Street
WRIGHT, MRS. MABEL OSGOOD.....	118 West 11th Street
WRIGHT, WILBUR T.....	2547 Valentine Avenue
WYCKOFF, REV. CHARLES S.....	582 Flatbush Avenue, Brooklyn
YOUNG, EPHRAIM M.....	2020 Broadway
YOUNG, FREDERICK STAFFORD.....	Union Club
YOUNG, JOHN ALVIN.....	Windsor Trust Co., 47th Street and Fifth Avenue
YOUNG, RICHARD N.....	11 Pine Street
ZABRISKIE, ANDREW C.....	716 Fifth Avenue

### Corresponding Members.

BROWN, HERBERT.....	Yuma, Arizona
BARBOUR, MRS. S. E.....	Eau Gallie, Florida
BROWN, WILLIAM HARVEY.....	Salisbury, Rhodesia, South Africa
CORNISH, C. J.....	Oxford House, Chiswick Hall, London, W., England
EATON, HOWARD.....	Medora, North Dakota
ELROD, M. J.....	Missoula, Montana
GOLDING, CAPT. THOS..	Care R. L. Golding, 21 Birch Lane, London, Eng.
GRAHAM, W. H. H.....	Winnipeg, Manitoba
GRIFFITH, WILLIAM A.....	Quebec, Canada
HAGENBECK, CARL.....	Thierpark, Hamburg, Germany
HUFFMAN, L. A.....	Miles City, Montana
MCCARTY, JOHN.....	Phoenix, Arizona
MARE, R. L.....	St. Johns, Newfoundland
MEYENBERG, E.....	Pecos City, Texas
SHELDON, CHARLES.....	Chihuahua, Mexico
STONE, ANDREW J.....	New York City
WILSON, T. E.....	Banff, Alberta
WILTSEE, E. A.....	Denver Club, Denver, Col.

### Summary of Membership.

Benefactor .....	1
Total number of Founders.....	22
“ “ Associate Founders....	12
“ “ Patrons .....	45
“ “ Life Members.....	155
“ “ Annual Members .....	1,098

January 1st 1904 Total of all classes..... 1,333

### Form of Bequest.

*I do hereby give and bequeath to the "NEW YORK ZOOLOGICAL SOCIETY," of the City of New York,* .....





PHOTOGRAPH.

YOUNG NUBIAN LION: DONGOLA.

ELWIN R. SANBORN.

## REPORT OF THE EXECUTIVE COMMITTEE

---

TO the New York Zoological Society the year 1903 has been marked by very substantial progress, both in the Zoological Park and in the Aquarium. Its chief events have been the completion of the Antelope House, and the commencement of the large Bird House, the Ostrich and Small Mammal Houses.

Of the success of the Zoological Park no better proof could be found than in the immense increase in attendance. The total attendance during 1903 was 1,164,146, as against 731,515 for 1902, being an increase of 432,631, or nearly sixty per cent. The largest day's attendance was on May 10th, when the Park was visited by 34,050 persons. Upon the completion of the Rapid Transit terminal at West Farms, the Committee confidently expects a still further increase in attendance, which in all probability will assume enormous proportions.

Throughout the year the condition of the animal collections at the Park has been very satisfactory, and the Committee takes pleasure in recording the fact that, for the first time since the Park was opened, all the animals have been provided with proper winter quarters.

The collections at the Park show a great increase in value over those of last year, and now consist of 536 mammals, 706 birds and 662 reptiles, making a total of 1,904.

The Llama House was completed, and its collection installed on the 7th of October, 1903. All the animals for this collection were presented to the Society by Mr. Robert S. Brewster, a member, and the Committee takes this opportunity to express its appreciation.

During the summer, four new cages were added to the bear dens, and they are, if possible, better than the old ones. With these new dens, we have adequate room for the finest collection of bears in the world, and the Committee intends to make special efforts to secure a very complete series.

The handsome granite fountain, donated by Mr. William Rockefeller, has been completed, and greatly adds to the beauty of Baird Court.

The Lydig memorial gate, presented by Mrs. Frank K. Sturgis, in memory of the Lydig family, which for many years owned about three-fourths of the Zoological Park, and to whom the public and the Society are indebted for the preservation of the magnificent forest existing there, has been completed. It is located at the top of the steps adjoining the Buffalo Range, a site which the Society intends to improve and beautify.

#### FINANCES.

The year 1903 closed with a substantial balance to the credit of the Society in each of its funds. In spite of the fact that over \$25,000 was expended for animals during the year, the financial condition of the Society is, on the whole, satisfactory; but we constantly require money for the purchase of new collections of animals. The need of funds for the erection of the Administration Building is equally urgent. Detailed statements of the various funds of the Society will be found in the Treasurer's report.

*Animal Fund.*—Under the agreement with the City, all moneys derived from privileges are used for the increase of the collections. Moneys from this source, and special donations, are placed in the Animal Fund, which at the close of the year showed a credit balance, as appears in the Treasurer's report.

*General Fund.*—The General Fund is replenished by the Members' dues. This fund is devoted to the general purposes of the Society, and in the future we must look to this fund not only for funds needed for the purchase of animals, but also for whatever scientific work may be undertaken.

*Park Improvement Fund.*—This Fund shows a balance of \$8,000. The Committee hopes to add greatly to this fund during the coming year, in order to provide for the erection of an Administration Building.

*Ground Improvement Fund.*—During the year 1903, the balance of the \$500,000 for construction appropriated by ex-Mayor Low's administration became available, \$75,000 on April 7th and \$175,000 on September 18th. A full statement of the expenditures, and balance remaining of this fund, will be found in the Treasurer's report.

*Maintenance of the Park (City Fund).*—It will be noted by an inspection of the Treasurer's report of the City Fund, that the Committee has succeeded in keeping within the maintenance



PHOTOGRAPH.

ELWIN R. SANBORN.

## LYDIG MEMORIAL GATEWAY.

Gift of Mrs. Frank K. Sturgis, as a memorial of the Lydig family.

allowed for 1903, which was \$104,965. A deficit was avoided solely by reason of the delay in the completion of the Antelope House and the Bird House, so that this fund was not called upon for the maintenance of the expensive collections contained in the former building until late in the year. The last administration, unfortunately, did not provide for an increase in the maintenance fund for 1904, but allotted to the Park the same amount as in 1903. By reason, however, of the great increase in the collections and in the attendance, the cost of maintenance will considerably exceed the amount allowed, and by the end of 1904 your Committee anticipates a deficit which must be met by the Society.

*Maintenance for Aquarium (Aquarium Fund).*—The maintenance provided for the Aquarium, known as the Aquarium Fund, has proved, with strict economy, sufficient for 1903. The same

amount (\$46,500) has been allotted to the Aquarium for 1904, and the Committee hopes, with careful management, to avoid a deficit in this Fund during the coming year. If the City had provided an increase of the maintenance, the additional amount could have been devoted to the increase of the collections exhibited in the Aquarium.

*Aquarium Improvement Fund.*—The bond issue of \$30,000 provided for the alteration and improvement of the Aquarium became available late in the spring, and is practically all under contract. A full statement of this fund will be found in the Treasurer's report.

#### MEMBERSHIP.

The present membership of the Society is as follows:

Founders .....	24	New members in 1903	2
Associate Founders..	12	“ “	—
Patrons .....	49	“ “	1
Life Members .....	165	“ “	9
Annual Members ...	1,103	“ “	211
<hr/>		<hr/>	
Total .....	1,353	“ “	223

The Society is in need of an increase in membership, and the most effective manner in which the present members can aid the organization is by sending in the names of friends, for election to the Society. From now on the privileges of members will be greatly enlarged, and an increasing proportion of the proceeds from annual dues will be devoted to publications and other benefits especially for members. The membership should be at least double its present size.

#### PUBLICATIONS.

During the year 1903, the four regular numbers of the quarterly Bulletin have been issued, as well as the Annual Report and the sixth edition of the Guide Book.

#### GIFTS.

The Society has been fortunate during the year in receiving a number of handsome donations, for which the Committee desires to take this opportunity to express the thanks of the Society.

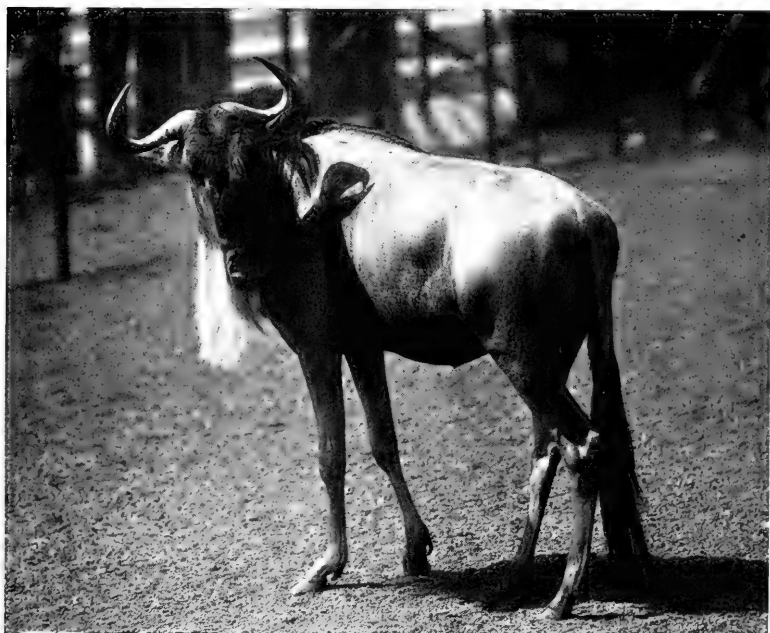




PHOTOGRAPH,

ELWIN R. SANBORN.

WHITE-TAILED GNU.



PHOTOGRAPH,

ELWIN R. SANBORN.

WHITE-BEARDED GNU.



A full statement of gifts will be found in this volume, but the following should be noted here:

Herd of 26 Bison, Herd of Elk, from Mr. William C. Whitney.  
1 pair of Llamas, 1 pair of Guanacos, 1 Vicuna, 1 Alpaca, from Mr. Robert S. Brewster.

1 Eland, 1 pair White-Tailed Gnu, 1 pair White-Bearded Gnu, from Mr. George F. Baker.

1 pair African Ostriches, 1 Baker's Roan Antelope, 1 Addax Antelope, 1 Beatrix Antelope, 1 Sing Sing Water-Buck, 1 pair Altai Wapiti, from Mrs. Frederic Ferris Thompson.

Herd of Fallow Deer, from Van Cortlandt Park.

Collection of Palms, from Mrs. Byron Sherman.

#### MEDICAL DEPARTMENT.

During the year 1903, the Medical Department, under the management of Dr. Harlow Brooks and Dr. W. Reid Blair, has been very successful in the treatment of the animals in the Park. Dr. Frank H. Miller, who had acted for some two years as Veterinarian, to the regret of the Committee resigned his position on May 27th, and Dr. Blair, who was his assistant, was appointed to fill the vacancy. Dr. Harlow Brooks has remained as Pathologist. The reports of Dr. Brooks and of Dr. Blair are published in full in this volume, and present matter of great interest.

The New York Zoological Society is believed to be unique in having a medical staff at the Park, and scientific data are being accumulated which will ultimately be of great interest in the care of animals. The Executive Committee is greatly gratified with the results achieved in this Department.

#### COBB ISLAND.

An important expedition was made by Mr. C. William Beebe, Curator of Birds, to Cobb Island, Virginia, for the purpose of making a study of the bird life on that Island. An elaborate and interesting report by Mr. Beebe is printed herewith. The expedition was arranged through the courtesy of Louis N. Whealton, Esq., a life member of the Society, who accompanied Mr. Beebe and greatly contributed to the success of the trip.

Owing to the condition of Mr. Beebe's health, the Executive Committee has granted him a leave of absence, in order that he may visit Mexico and study the conditions of bird life there.

## SCULPTURE AND PAINTING.

During the year a large number of animal painters and sculptors have taken advantage of the facilities afforded them in the Park at large, and especially by the studio in the Lion House. This feature will probably be greatly developed in the future.

## CALAVERAS TREES.

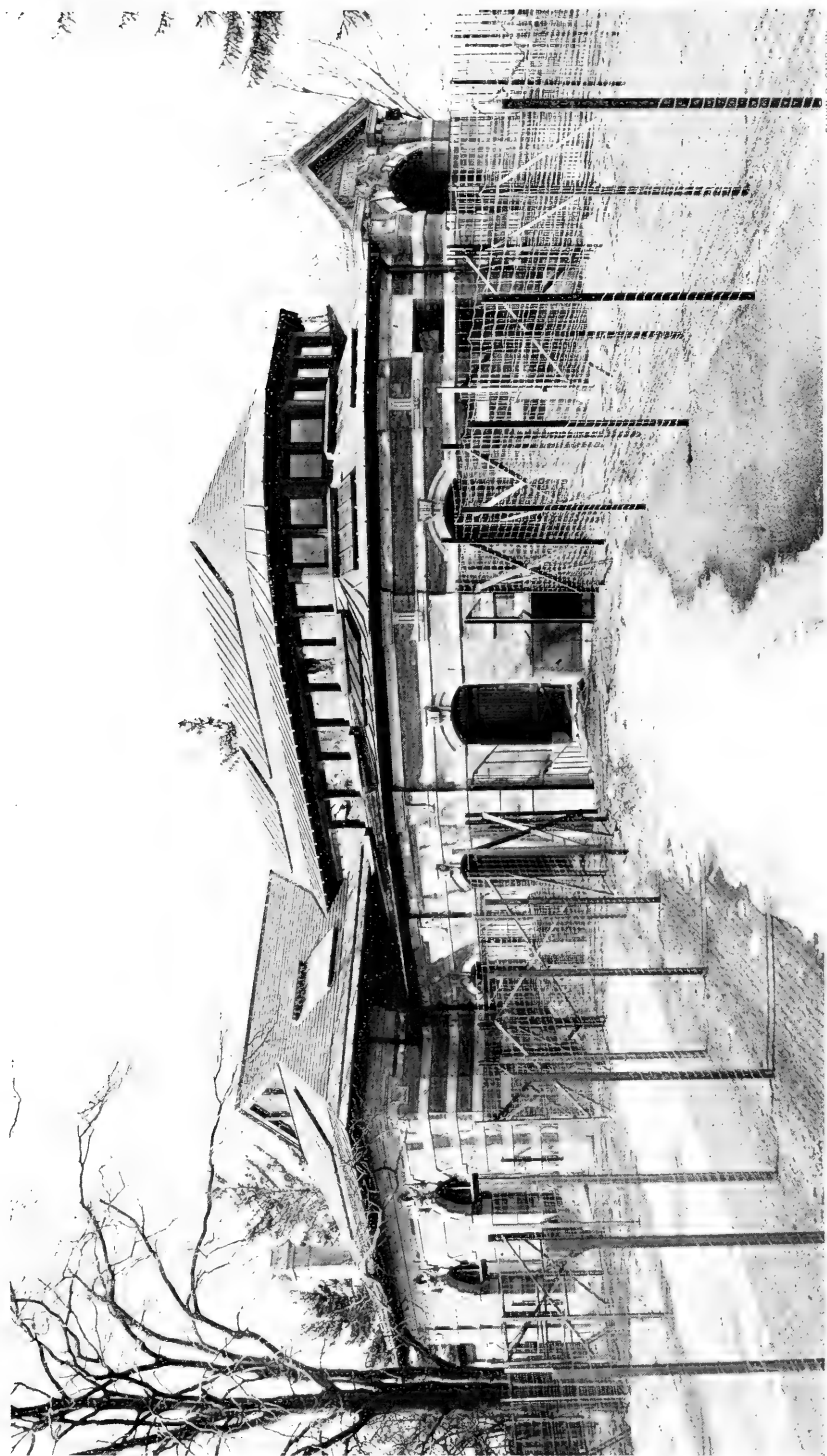
At the Annual Meeting of the Society, strong resolutions were passed, calling on Congress to save the Calaveras groves of big trees in California, now threatened with destruction. Copies of this resolution have been sent to parties interested, and the Committee is endeavoring to promote legislation to the end that these trees, the oldest living things on earth, may be protected. At the present writing the prospect of favorable action by Congress is very promising.

## WORK AT THE PARK.

During the year, the rockwork in the outdoor cages of the Lion House has been completed, and the contract for the Bird House, at the northwest corner of Baird Court, has been awarded, and work begun. The Ostrich and Small Mammal Houses are also under contract, and their construction is progressing rapidly. We hope to have these buildings ready for use by midsummer at the latest.

A number of small installations are under consideration, the most notable of which is the Pheasants' Aviary, extending along the west side of the Aquatic Mammals' Pond; and if a sufficient bond issue can be obtained during the coming year, further improvements, on a large scale, will be inaugurated. The buildings and installations most needed are as follows:

- Completion of Baird Court and Concourse,
- Completion of Sea Lion Pool,
- Elephant House,
- Lakeside Restaurant,
- Additional Sheep Enclosures,
- Aviaries for Pheasants, Grouse, Cranes and Eagles,
- Extension to Wolf Dens,
- Tropical Deer House,
- Completion of Motor Road,
- Enclosure for Wild Horses, Cattle and Swine,
- Altai Wapiti House,
- Hospital,
- Boat House and Entrance at West Farms,
- New Roads, Walks, Planting and Miscellaneous Improvements.



PHOTOGRAPH

NEW ANTELOPE HOUSE.

View from the north-east, showing portion of the yards and main entrance.

ELWIN R. SARGENT



A bond issue of \$550,000 is urgently needed for the above purposes, and the Society hopes that the Board of Estimate and Apportionment will appropriate this amount for the Park during the coming two years.

The Society proposes to secure, from private sources, funds for an Administration Building, to be located near Baird Court. This building is for a much-needed headquarters for members of the Society, and will greatly increase the value of membership.

The administration of Park Commissioner Eustis has been signalized by a number of notable improvements in the immediate surroundings of the Park, the chief of which is the construction of a handsome single arch granite bridge across the Bronx at our northern boundary, and the improvement of Pelham Avenue at that point.

The development of Bronx Park immediately to the north of the Zoological Park has been seriously undertaken, and two driveways have been completed through Bronx Park, from the Botanical Gardens, one terminating at what will be our main entrance, upon the completion of the Concourse and Baird Court, and the other at the Northwest Entrance.

Commissioner Eustis has also been helpful in obtaining the approval of the City to the addition of one block of land at the West Farms Entrance to the Park, which will be developed in connection with the Boat House and Southern Entrance to the Park. A handsome growth of large and fine trees still exists on the eastern side of the Park, but beyond its boundaries, and the Society has urged the City to acquire this land as an addition to Bronx Park in order that the splendid forest thereon may be preserved.

#### AQUARIUM.

During the year the attendance at the Aquarium was considerably over a million and a half. The largest daily attendance of which record was kept was on Labor Day, when 18,800 persons visited the Aquarium, a notable increase over the largest day for the preceding year. The average attendance on Sundays during the summer months is over 10,000, and the average weekday attendance during the summer months is about 6,200. The actual average throughout the year, including the days when the Aquarium was partly closed for repairs, was 4,240.

During the year the Aquarium building has been greatly improved from the proceeds of the \$30,000 bonds granted by the City. With this money a large number of additional sky-

lights have been provided, so as to illumine the wall tanks and the central floor pools. Other alterations have been made in the interior, and a reservoir for warm and pure salt water is being constructed in Battery Park near the Aquarium. When this tank is completed it will effect a radical improvement in the condition of the collection of marine fishes and invertebrates.

The Aquarium building has been painted throughout, with especial reference to the satisfactory exhibition of the collections. All the above work has been very satisfactorily conducted under the direction of Messrs. Barney & Chapman, architects, who have been employed by the Committee for these alterations in the Aquarium. A further bond issue will ultimately be needed to provide for an additional exterior tank for salt water, and for a new water supply, heating and ventilating system. The bond issue provided for 1903 proved inadequate to supply these items.

The collections themselves have greatly increased in value during the year, and now number 2,000 living specimens. A fish hatchery was installed early in the year, and was a source of great interest to visitors. More than two million young fishes were raised in this hatchery, and distributed in State waters.

The Zoological Society, on taking over the Aquarium, found all the tanks lined with glaring white tile, producing an unpleasant effect on the visitor, and not properly exhibiting the collections. These tiles have been replaced by rockwork, representing as nearly as possible the natural surroundings of each fish. This substitution of rockwork, the design being varied in each tank, has greatly improved the appearance of the Aquarium, and rendered imperative an additional supply of light.

In addition to these items, a great number of minor improvements and changes have been made, and will continue to be made during the present year. When the outdoor tanks are in full working operation, and proper filtering can be provided for water, both salt and fresh, the Aquarium will be entirely transformed. Various other improvements are in contemplation, and will be made as fast as money can be provided for the purpose.

#### ACKNOWLEDGMENTS.

The Committee desires to acknowledge its great obligation to Hon. John E. Eustis, Park Commissioner for the Borough of The Bronx, for his assistance in the development of the Zoological Park, and to Hon. William R. Willcox, President of the Park Board, in connection with the Aquarium. Acknowledgments



are also due to the officers of the late administration, especially to the Mayor, Hon. Seth Low, the Comptroller, Hon. Edward M. Grout, and the President of the Board of Aldermen, Hon. Charles V. Fornes, all of whom have in every way facilitated the work of the Society.

Most important of all, the Executive Committee acknowledges the devotion and energy of the Director of the Zoological Park, and of all the members of his staff, which have made possible the uniform success that has marked the development of that institution. The Director of the Aquarium, and his assistants, also are entitled to great credit for the manner in which the Aquarium has been conducted during the year 1903.

Respectfully submitted,

CHARLES T. BARNEY, *Chairman*.

HENRY FAIRFIELD OSBORN,	MADISON GRANT,
JOHN S. BARNES,	PHILIP SCHUYLER,
WILLIAM WHITE NILES,	SAMUEL THORNE,
LEVI P. MORTON, <i>Ex-officio</i> .	

January 1, 1904.

# Treasurer's Reports.

FOR THE YEAR ENDING DECEMBER 31, 1903.

*The annual expenditure of the various funds is shown in appended statements.*

## Park Improvement Fund.

### RECEIPTS.

Cash in Treasury, January 1, 1903.....	\$12,462 17
Refund of unexpended balance account European Trip	\$122 80
Adee House Rental .....	245 74— 368 54
	<hr/>
	\$12,830 71

### EXPENDITURES.

Engineering .....	\$300 84
Express Charges on Animals.....	654 19
Landscape Architecture .....	306 75
General Expenses .....	430 61
Maintenance Shortage for 1902.....	2,757 57—\$4,449 96
Cash in Treasury, December 31, 1903.....	8,380 75
	<hr/>
	\$12,830 71

H. R. MITCHELL,  
*Chief Clerk.*

January 1, 1904.

PERCY R. PYNE,  
*Treasurer.*

Examined and found correct by the New York Audit Company.

## General Fund.

## RECEIPTS.

Cash Balance in Treasury, January 1, 1903.....	\$3,814 67
Annual dues from members.....	\$9,790 00
Life membership fees .....	1,800 00
Interest .....	34 59
Guide Books .....	1,337 51
Income from Stokes' Bird Fund.....	127 50— 13,089 60
	<hr/> \$16,904 27

## EXPENDITURES.

Stationery and office supplies.....	\$767 50
Photographs and slides .....	1,579 91
Annual Report and Bulletin.....	2,583 21
Advertising .....	436 70
Miscellaneous expenses and supplies.....	487 73
General office expenses .....	1,921 09
Treasurer's office expenses .....	414 75
Library .....	456 03
Salary of Secretary .....	4,000 00
Employers' insurance .....	322 93
European trip, account Aquarium.....	73 67
Insurance .....	345 88
Bureau of Information .....	287 48
Aquarium, expenses .....	19 75
Publications for members .....	367 50—\$14,064 13
Cash balance in Treasury, January 1, 1904.....	2,840 14
	<hr/> \$16,904 27

H. R. MITCHELL,  
*Chief Clerk.*

PERCY R. PYNE,  
*Treasurer.*

January 1, 1904.

Examined and found correct by the New York Audit Company.

# Animal Fund.

## RECEIPTS.

Cash in Treasury, January 1, 1903.....	\$8,304 19
Receipts at Park:	
Admissions .....	\$5,912 95
Checking .....	156 10
Rents .....	397 26
Boating .....	325 00
Privilege account .....	2,500 00
Sale of Animals .....	389 60
Miscellaneous Receipts:	
Special Subscriptions—	
Mrs. Mary Clarke Thompson.....	\$4,000 00
George F. Baker .....	4,000 00
Robert S. Brewster .....	1,200 00
Miscellaneous items .....	666 14—9,866 14—
	19,547 05
	<hr/>
	\$27,851 24

## EXPENDITURES.

Purchase of Animals:	
Mammals .....	\$22,318 38
Birds .....	1,738 25
Reptiles .....	459 66—\$24,516 29
Express and other charges.....	1,031 77
Traveling and other expenses.....	72 32—\$25,620 38
Cash in Treasury, December 31, 1903.....	2,230 86
	<hr/>
	\$27,851 24

H. R. MITCHELL,  
*Chief Clerk.*

PERCY R. PYNE,  
*Treasurer.*

January 1, 1904.

Examined and found correct by the New York Audit Company.

**Maintenance Fund.**

## RECEIPTS.

Received from the City on account of Maintenance Appropriation of \$104,965 for the year.....	\$92,522 77
Balance due from City:	
Bills rendered—November supplies .....	\$4,522 10
Pay-rolls last half of December. ....	2,911 45
December supplies .....	5,008 68—12,442 23
	<hr/> \$104,965 00

## EXPENDITURES.

General administration .....	\$10,726 38
Maintenance of buildings and care of animals....	28,983 57
Maintenance and care of grounds.....	27,505 01
Tools and hardware .....	2,452 76
Paints and oils .....	1,277 15
Office supplies and printing.....	603 48
Uniforms and badges .....	1,364 75
Horses and vehicles .....	309 73
Repairs .....	614 26
Telephone and electrical supplies.....	234 44
Telephone service and tolls.....	385 65
Postage and telegraph, and express.....	869 38
Food for animals .....	17,875 43
Fuel .....	5,570 24
Signs and labels .....	180 45
Engineering supplies .....	69 62
Drugs and medicines .....	329 32
Lumber .....	1,059 36
Miscellaneous supplies .....	861 47
Surgical instruments and appliances.....	21 70
Plumbing supplies .....	562 08
Electric lighting .....	138 98
Sand .....	309 67
Nursery supplies .....	22 15
Nursery stock and seeds.....	42 71
Office furniture and fixtures.....	226 26
Sanitation .....	224 86
Medical attendance (animals).....	370 00
Medical attendance (employés).....	35 00
Fencing and netting .....	445 05
Ice .....	359 51
Park baskets .....	175 00
Wagon scales .....	189 60
Trap rock .....	569 98
	<hr/> \$104,965 00

H. R. MITCHELL,  
*Chief Clerk.*

PERCY R. PYNE,  
*Treasurer.*

January 1, 1904.

Examined and found correct by the New York Audit Company.

## Ground Improvement Fund Balance Sheet.

(Showing status of Appropriations aggregating \$500,000.)

## RECEIPTS.

## Appropriation of Board of Estimate and Apportionment:

Available May 18, 1902.....	\$250,000 00	
February 20, 1903 .....	75,000 00	
July 3, 1903 .....	175,000 00	
		\$500,000 00
Premium on the sale of bonds to December 31, 1903 .....		2,369 64
		<u>\$502,369 64</u>

## EXPENDITURES.

*Through Park Department:*

Contract, Thomas Dwyer, Antelope House..	\$54,900 00	
Contract, Wm. H. Wright & Son, Bear Dens	4,877 00	
Contract for improving West Farms Road..	3,754 70	
Over-expenditure last appropriation.....	95 58	
Miscellaneous expenditures .....	3,853 58	
Contract, George L. Walker, Small Mammal and Ostrich Houses .....	73,780 00	
Contract, George L. Walker, alteration of floor construction and drainage system for Small Mammal and Ostrich Houses.	378 00	
Contract, George L. Walker, Large Bird House .....	114,944 00	
Contract, George L. Walker, extra masonry in foundation of Large Bird House.....	700 00	
Contract, Page Woven Wire Fence Co., Antelope House Yards .....	8,713 00	
Contract, Julian Scholl & Co., steam roller.	1,890 00	
Judgment of T. W. Timpson & Co., account work performed on abandoned contract..	1,140 00—	\$269,025 86

*By the Zoological Society: Bill to reimburse Park Improvement Fund, account advanced to complete buildings on Baird Court—*

Monkey House .....	\$5,374 77	
Lion House .....	9,262 16	
Antelope House .....	1,189 00—	15,825 93
Guard rails .....	1,730 52	
Seeds and plants .....	1,002 95	
Public Comfort Building No. 1.....	210 50	
Bear Dens, addition .....	9,326 41	
Mountain Sheep Hill .....	3,831 51	
Buffalo Range drainage .....	2,331 50	
Beaver Valley Walk .....	4,191 71	
Grading and seeding .....	932 12	
Drainage Elephant House site.....	256 31	
Baird Court retaining wall .....	155 80	
Baird Court walks .....	4,566 11	
Buffalo and Restaurant water main.....	549 87	
Beaver Pond .....	38 25	
Machinery, tools, and hardware.....	874 04	

Forward .....	\$29,997 60	\$284,851 79
---------------	-------------	--------------

Brought forward.....	\$29,997 60	\$284,851 79
Photograph Gallery .....	95 54	
Crematory .....	257 58	
Grading and seeding Auto Road.....	192 38	
Bronx River Walk .....	9,138 66	
Antelope House .....	2,559 36	
Lion House .....	12,730 18	
Miscellaneous fencing and netting .....	952 58	
Improvements East of Bronx River.....	2,229 99	
Pavilion No. 3 .....	90 00	
Corrals and walks .....	122 38	
Miscellaneous ground improvement items....	8,870 67	
Mountain Sheep Walk .....	875 62	
Breeding House .....	944 84	
Reptile House improvements .....	183 44	
100 Park benches .....	595 00	
Grading and seeding Beaver Valley Walk..	681 42	
Tortoise Enclosure .....	1,373 82	
Electric lighting—Reptile, Mammal, and Bird Houses .....	959 57	
Lydig Gate Foundation .....	44 63	
Llama House Yards .....	948 73	
Boundary Fence along the entire Eastern Boundary .....	3,064 44	
Water supply for Italian Fountain.....	287 95	
Bird Enclosure .....	380 40	
Red Deer Range drainage .....	442 52	
Trimming, pruning, and planting .....	3,417 73	
Ducker Portable Houses .....	573 50	
Corral for Wild Horses .....	682 65	
Miscellaneous materials and supplies.....	1,278 66	
Mammal Pond fences .....	798 30	
Lion House (outside cages).....	3,449 08	
Bird House (large) .....	3,310 51	
Abattoir and stable .....	990 91	
Antelope House Yards .....	14,690 79	
Lion House walks .....	1,257 77	
Cement .....	232 55	
Buffalo Range division fence .....	599 46	
Soda Pavilion .....	611 51	
Small Mammal House .....	949 28	
Ostrich House .....	949 28	
Llama House .....	2,046 38	
Removal of Mammal House to Nursery....	800 00	
Additional wall, Prairie Dog Village.....	297 17	
Mammal House fence .....	143 07	
Sika Deer Shelter .....	225 00	
Buffalo Corrals .....	409 67	
Artists' Room, Lion House .....	82 45	
Fallow Deer Shelter and Yard.....	378 62	
Animal Storehouse .....	1,011 29—	117,210 93
Balance available for expenditure.....		100,306 92
		<hr/>
		\$502,369 64

H. R. MITCHELL,  
*Chief Clerk.*

PERCY R. PYNE,  
*Treasurer.*

January 1, 1904.

Examined and found correct by the New York Audit Company.

**Aquarium Improvement Fund Balance Sheet.***(Showing status of Appropriation of \$30,000.)***RECEIPTS.**

Appropriation of Board of Estimate and Apportionment..... \$30,000 00

**EXPENDITURES.***Through Park Department:*

Contract, Charles Wille, skylights.....	\$6,850 00	
Contract, C. Nally, reservoir.....	18,496 00	
Architects' commission on above contracts....	1,267 30	\$26,613 30
Unexpended balance .....		3,386 70
		<hr/> \$30,000 00

**Aquarium Fund.****RECEIPTS.**

Received from City on account of Aquarium appropriation of \$46,500 for 1903 .....	\$38,680 42
Balance due from City .....	7,773 26
Unexpended balance .....	46 32
	<hr/> \$46,500 00

**EXPENDITURES.**

Pay-rolls for employés .....	\$26,552 02
Pay-rolls for painters .....	2,320 00
Paint and painting of roof.....	1,300 00
Alterations .....	3,100 31
Coal .....	6,320 66
Live specimens .....	2,500 00
Fish food .....	1,000 00
Gas .....	599 67
Telephone service .....	197 34
Ice for twelve months.....	59 72
Incidental expenses .....	600 00
Uniforms and caps .....	121 45
Rock for lining tanks .....	73 14
Books for Library .....	79 43
Furniture, one desk .....	15 00
Supplies for engine-room and for general use.....	1,464 57
Stationery and printing .....	150 37
Unexpended balance .....	46 32
	<hr/> \$46,500 00

E. R. SAMPSON,  
*Disbursing Clerk.*

PERCY R. PYNE,  
*Treasurer.*

January 1, 1904.

Examined and found correct by the New York Audit Company.





PHOTOGRAPH.

BARBARY LIONESS AND CUBS.

ELWIN R. SANBORN.



# REPORT OF THE DIRECTOR

## OF THE

### ZOOLOGICAL PARK.

FOR the year 1903 we are able to report a great advance toward the completion of the Zoological Park. Not only has the usual progress been made in the construction of permanent improvements, but the collections have been increased by the acquisition of many new animals of noteworthy value. In response to this progress, the attendance of visitors has also increased over the number of the previous year by nearly sixty per cent.

Of the events fully accomplished during the year, the most important were the opening of the Lion House, the completion and stocking of the Antelope House, the receipt of the Whitney Buffalo herd and Elk herd, the completion of the four new Bear Dens, and the building and stocking of the Llama House. Important events provided for development and completion in the near future were the building of the large Bird House, Ostrich and Small Mammal Houses, large Deer Barn, and the improvement of the south half of Baird Court.

It is again a satisfaction to be able to report that the relations of the Zoological Park with the public, and the various City Departments with which it regularly comes in touch, continue to be cordial. The usefulness of the Park to educators and students, to animal painters and sculptors, to authors and illustrators, and also to the officers of other zoological gardens and parks, is of sufficient importance to indicate, even at this early date, the value of a zoological park as an educational institution.

#### ATTENDANCE.

Notwithstanding the fact that the street railway facilities for reaching the entrances to the Zoological Park are as far away as ever, the attendance of visitors has shown a surprising increase. The absence of a street railway on Pelham Avenue is a source of constant surprise and annoyance to visitors, and this dissatisfaction is very frequently expressed by those who are compelled

to walk the half mile between the Northwest Entrance and the railways at Fordham.

The monthly record of visitors for the year is as follows:

	1902	1903
January .....	12,958	11,405
February .....	12,155	42,134
March .....	54,742	81,222
April .....	56,081	133,662
May .....	105,519	187,940
June .....	89,691	72,776
July .....	87,164	154,290
August .....	126,874	155,505
September .....	63,370	151,162
October .....	45,262	70,060
November .....	68,268	89,215
December .....	9,431	14,775
	<hr/> 731,515	<hr/> 1,164,146

Total increase for the year, 432,631, or 59 per cent.

Increase in 1902, 38 per cent.

#### PRACTICAL WORKING OF THE PRIMATES' HOUSE.

The Primates' House has now been in active use for a little more than two years; and inasmuch as the entire building was evolved from our own ideas, it is now proper to place on record our estimate of its working value. It is no exaggeration to say that this building has not only come up to our expectations, but, in many respects, has surpassed them.

All persons familiar with zoological gardens are well aware of the fact that the odors of monkey houses are difficult problems to contend with. Wherever either ventilation or cage sanitation is imperfect, the odors become disagreeable—especially in winter weather, when doors and windows must be closed, and the supply of pure air is necessarily restricted. The best evidence that can be offered of the success of the ventilating system of our Primates' House lies in the expressions of satisfaction that have been offered, voluntarily, by visitors. The absence of the usual ape and monkey odors from the Primates' House—even in the severest winter weather—is frequently remarked by visitors, and from this fact we have reason to believe that the air supply is pure, and therefore **beneficial** to the living inhabitants of the building.

The question of the necessity of mechanical or forced-draft system for this building may be considered settled by conclusive evidence that it is not necessary. The supply of outside air that is continually brought into the building, warmed over coils of hot-water pipes, and delivered both into the large cages and the auditorium, finds its way out of the top of the cages and the main hall by a system of upper currents, which carries away what would otherwise be objectionable animal odors.

The great decrease in the number of cases of tuberculosis among the primates may fairly be regarded as evidence that the air supply of the Primates' House is very nearly what it should be. During the year 1902, and immediately following the opening of this building, the animals within it were subject to the conditions under which they entered it, and the death-rate from tuberculosis was as heavy as it usually is in such collections. During the first year of the building's use, the animals which entered the Primates' House with tuberculosis disappeared by death, and were replaced by healthy animals. The mortality records of 1903 show a decrease in the death-rate of the primates of nearly fifty per cent., bringing the total for the year down to a comparatively small number.

In Europe it is a common practice to keep all oranges and chimpanzees behind glass. Our policy has been to keep nothing, save marmosets, behind glass, and to give the anthropoid apes as much fresh air as they can stand without contracting severe colds. In fact, in comparison with the views of some European authorities respecting the air supply of anthropoid apes, we have gone to the opposite extreme, and prefer to furnish to the oranges and chimpanzees a supply of air so cool and fresh that occasionally it produces a head cold, rather than weaken the lungs of those creatures by a constant high temperature, and consequent diminution of vitality.

All the large cages of the Primates' House have proven conducive to great activity on the part of their living inhabitants. The only cases of cage paralysis (three in number) have occurred in the small side cages. It must be borne in mind, however, that in every large collection of primates there must be a liberal number of small cages for the use of timid animals that fare badly in mixed company, and also for quarrelsome individuals that will not live peaceably in the cages that are devoted to groups.

The lignolith floors of our cages have proven of extreme value in the matter of cleanliness, and the manner in which that material has been applied to connect the floor with the lower portions

of the walls without corners or seams, has undoubtedly exercised a great influence on the general cleanliness of the building, and absence of odors.

It is a great satisfaction to be able to report that, were we to build next year a new house for primates, it would be very difficult to suggest even one important improvement upon the present structure. That the building is crowded with visitors during Saturdays and Sundays of the season when visitors are most numerous, need cause neither surprise nor regret; for were the structure five times as large as it now is, it would, during those periods, be crowded precisely as it is now. So long as apes and monkeys are in good health, and perform their usual antics on horizontal bar and trapeze, just so long will people pack six deep in front of their cages, and stand until they are compelled by policemen and keepers to move on.

#### PRACTICAL WORKING OF THE LION HOUSE.

The Lion House has now been in actual use a little more than one year, during which time it has been thoroughly tested. Thus far but two defects have been revealed, both of which are of so simple a character that they can easily be remedied, and the necessary substitution of materials will be accomplished at an early date, with no disturbance to the daily routine. The Lion House may be described as a handsome domicile joined to an elaborate but smoothly-working machine. It appears to be the verdict of the public that in view of the fine facilities it affords for the exhibition of its animals, for their management and care, and for the general comfort of the public, this building is worth all that it has cost.

Beyond question, the animals are as contented, as happy and as active in their cages as such animals ever could be in captivity. The wire cage-fronts have proven an unqualified success, and the color-scheme of the cage interiors is almost everything that could be desired for the exhibition of large felines. The elevated balconies and the high steps leading up to them are used by the majority of the animals to a gratifying extent, and beyond question, the climbing done by the animals from day to day is beneficial to their health and spirits. It has been noticed, with particular pleasure, that the lions born and thus far reared in the Lion House use these steps and balconies very freely, quite as if they appreciate the climbing privilege more than those animals which matured elsewhere without similar opportunities.

One of the best indices of the health, spirits and contentment of the animals in the Lion House is to be found in their desire to reproduce their kind. Thus far the results have been as follows:

Out of the first litter of five lion cubs, one cub died by accident, but the other four have developed as finely as if they had been bred and reared in an African jungle. The second litter of three lion cubs is progressing, and promises to develop successfully. The young Senegal lioness died in giving birth to her first cubs, as also did the female Indian leopard. A third litter of lion cubs is now due.

It is believed that the income from the breeding and rearing of young animals in the Lion House will be of material assistance in keeping up the supply of large felines.

The general health of the animals in the Lion House has been well-nigh perfect, the only death not due to accident being that of the cheetah, which occurred within a comparatively short time after its arrival, and was chargeable to long-standing causes.

The mechanical working of the Lion House has proven to be one of its best features. The plan for the shifting and transfer of the animals works excellently. Its practical effectiveness may be summarized in the following incident:

A tigress which was found at six o'clock in the evening with a large piece of bone fast upon one of her canine teeth, and greatly distressed thereby, was taken out of her cage by means of the shifting car, run into the outdoor area, where the remaining daylight was sufficient, the obstruction was removed, and the animal replaced in her cage safely and without worry, in precisely twenty minutes from the assembling of the men to remove her.

#### ANIMAL COLLECTIONS.

During the past year the increase in both the scientific and intrinsic values of the animal collections of the Park has been really great, and it is by no means expressed in any of the figures representing the number of individuals in the various departments on December 31st. The most noteworthy increase has been in the mammal collections.

The collections of small mammals, birds and reptiles have so completely filled the installations provided for them that no marked increase has been possible. The Aquatic Birds' House has long been filled to overflowing. The erection of the new house for small mammals, and the consequent removal of the

temporary building, has caused the collection of small mammals to disappear from exhibition, and has also operated to prevent, temporarily, the acquisition of new specimens.

#### DEPARTMENT OF MAMMALS.

The collections in this Department were increased during the past year by the addition of about \$34,000.00 worth of new specimens, representing many species new to the Park. This increase was the greatest that has yet been made in one year. It is a source of sincere gratification to be able to report that fully one-half of our splendid list of accessions for 1903 came to the Society as special gifts from its Founders and other members.

The most noteworthy individual gift came from the Hon. William C. Whitney, who presented to the Society his fine buffalo herd of twenty-six animals, which had previously inhabited his park on October Mountain, near Lenox, Massachusetts. This splendid gift, which was delivered at the Park without any expense whatever to the Zoological Society, places the Society in possession of not only the largest herd of buffaloes on public exhibition, but also a herd second to none in the quality of its members. The presence in this herd of a large number of female animals renders it particularly valuable for breeding purposes. All the animals were crated on October Mountain and transported to the Zoological Park without the slightest mishap or accident. This herd has been kept separate from the Society's original herd, which occupies a separate range and shelter.

Coincident with the delivery of the buffalo herd, Mr. Whitney also presented a herd of ten elk of choice breed, which were also delivered at the Park at the expense of the donor, and now constitute an exhibit of which the Society is justly proud.

The animals in the Antelope House represent a cash value of about \$15,000.00, and more than one-half of them stand as gifts. Through much correspondence, lasting through a period of several months, the Society had the good fortune to secure for the Antelope House a remarkably large proportion of rare species.

Mr. George F. Baker generously provided funds for the purchase of a very fine male eland, from the herd of the Duke of Bedford; a pair of white-tailed gnu and a pair of white-bearded gnu, from German East Africa. Mrs. Frederic Ferris Thompson provided funds for the purchase of three very rare African antelopes, a beatrix antelope, a pair of Altai wapiti and a pair of African ostriches. Mr. Robert S. Brewster presented a complete





PHOTOGRAPH.

BAKER'S ROAN ANTELOPE.

ELWIN R. SANDOZ.



collection of llamas, guanacos, vicunias and alpacas, with which to fill the new Llama House. After about two years of continuous effort, Mr. Charles Sheldon succeeded in securing a Mexican grizzly bear, which he presented to the Society.

The funds provided in 1901 by Mrs. Hugh D. Auchincloss, for the purchase of a snow leopard, secured a very fine male specimen early in 1903, and it now forms one of the chief attractions of the Lion House. Being a hardy animal, it is living continuously in one of the outdoor cages, beside the Manchurian leopard, and has not been in the least inconvenienced by a temperature of sixteen degrees below zero.

An order that was placed in 1903 for three pairs of Steller's sea lions was, after many futile efforts, finally filled late in 1903. Six young specimens were received from the coast of California; but, with one exception, their fate has been exceedingly unfortunate. Shortly after their arrival two died of pneumonia, and three others died from ptomaine poisoning, leaving only a solitary individual.

From Mr. William Rockefeller, six Russian fallow deer, specially selected by Carl Hagenbeck, for breeding purposes, were received by gift. Mr. David S. Cowles presented a black bear cub from the Laurentian Mountains, Canada. From Mr. John J. Ittner, two fine male mandrills were received. From the Park Department for the Borough of the Bronx, a herd of twenty-five fallow deer was received by gift.

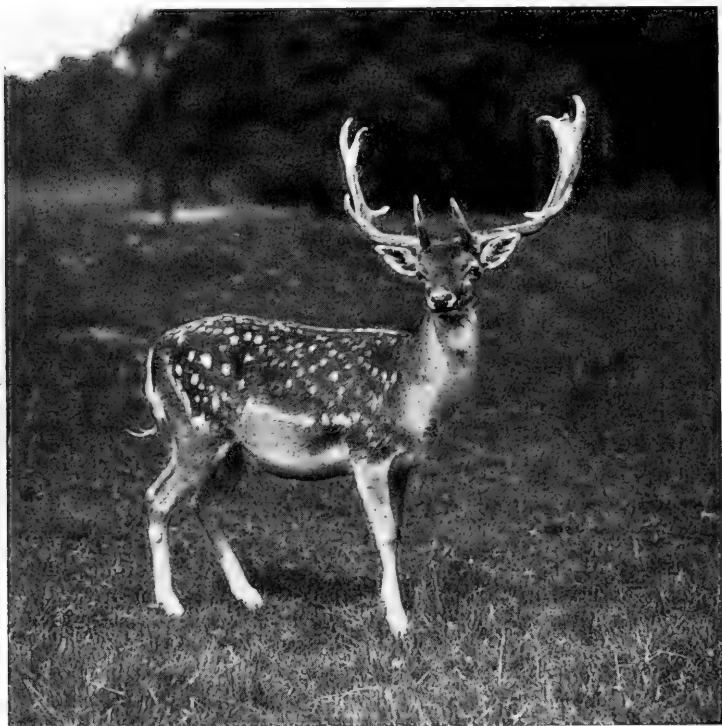
From Captain Thomas Golding the Society purchased several very interesting importations from northern China and Japan, the most important specimens being two Tscheli monkeys, one Chinese macaque and a rare palm civit. From Singapore, Captain Golding brought a half-grown specimen of a very rare anthropoid ape called the siamang, the first animal of that species to come into the possession of the Society.

A pair of fine giraffes from German East Africa was purchased of Mr. Hagenbeck, and safely installed in the Antelope House on October 17th. Upon their arrival the male specimen measured 10 feet, 8 inches, and the female was 10 feet, 1 inch high. These animals are in excellent health, very active in taking exercise in their compartment, and they appear to be growing satisfactorily. The pair cost the Society \$5,500.00, which, considering the rarity of living examples of this species, was a very moderate price.

The health of the animals in the mammal collection has been fairly satisfactory. The deaths have been much fewer than dur-

ing the previous year, and there has been no loss of animals of great value. The most valuable animal lost by death was the large female orang-utan, which, having been captured when fully adult, was necessarily short-lived.

The health of the animals in the Lion House has been particu-



FALLOW DEER.

Herds of fallow deer have been presented by Mr. Wm. Rockefeller and the Park Commissioner of the Borough of the Bronx.

larly gratifying, there having been but one case of illness, and but one death save by causes to be classed as accidents.

With the disappearance of the animals which in 1901-2 entered the Primates' House suffering from various diseases, the collection has settled down to a normal condition of health, and the death-rate for the year 1903 was really very low. Such deaths as did occur were chiefly amongst the delicate and short-lived species, such as the howlers, marmosets and spider monkeys. The only baboon lost during the year was a female which died in par-

turition. With the elimination of the two apes that entered the Primates' House in a diseased condition, the three remaining anthropoid apes have thriven surprisingly. They are not only in good health, but are exceedingly active, and growing rapidly.

The health of all the foreign tropical deer in the Park has been excellent; but the filaria affecting the old elk herd has caused the loss of several individuals, and gastro-enteritis has also carried off several of our native deer. It is very unfortunate that our native deer should be so difficult to acclimatize in New York, and keep in good health.

The following is a statement of the species and specimens of mammals on hand on December 31st, 1903:

Primates .....	40	species.	96	specimens.
Chiroptera .....	1	"	8	"
Carnivora .....	49	"	132	"
Pinnipedia .....	2	"	9	"
Rodentia .....	12	"	78	"
Ungulata .....	47	"	205	"
Marsupialia .....	2	"	8	"
	<hr/>		<hr/>	
	153	"	536	"
Received by gift .....			163	
Purchased .....			137	
Born .....			61	

#### DEPARTMENT OF BIRDS.

It has already been stated that in this Department no substantial increase in the number of species has been possible, for the reason that all available accommodations were so well filled. The most noteworthy accessions consisted of herons, egrets and ducks purchased at Brownsville, Texas, and Orlando, Florida, and the collection of gulls, terns and other water-birds secured by Curator Beebe on his expedition to Cobb Island. Special mention should be made of the collection of birds received as a gift from Mr. Louis N. Whealton, and also of the generous and effective cooperation which Mr. Whealton extended to the Society's representative on Cobb Island. Mr. Whealton's gift embraces specimens of three species of ducks, two swans, two Egyptian geese, five species of terns and gulls and also specimens of the black skimmer. Mr. Beebe's observations and work on Cobb Island

will be fully described elsewhere in this volume. Among the birds of special interest acquired during the year the following were the most noteworthy:

A fine adult specimen of the great white heron—a bird of exceeding rarity—was received by purchase from Miami, Florida. Two African ostriches were received by gift from Mrs. Frederic Ferris Thompson, and pending the completion of the Ostrich House, have been placed on exhibition in the Antelope House. Three blue geese, and specimens of the avocet and stilt, were received from Brownsville, Texas.

Two specimens of the pinnated grouse were received by exchange; and a ptarmigan, from Alaska, was purchased in December, but survived in the Park only three days.

To the Bird Department, the most notable event of the year was the beginning of work on the erection of the Large Bird House. Owing to the very considerable cost represented by the lowest bid when the contract for that building was first advertised, in the spring of 1903, the contract was withdrawn, the plans were restudied with a view to reducing the cost of the structure, and later on a new contract was advertised. On this occasion the lowest bid was accepted, and by the end of December the foundation walls were ready to receive the base course of granite. It is believed that this building will be as perfect in its appointments for the care of its collections as any other which the Society has erected. It will contain a really great amount of cage room, outdoors as well as within, and it will accommodate as large a collection of perching birds, shore birds and members of the Order *Psittaci* (parrots, macaws, etc.), as the Society will desire to exhibit.

During a large portion of the year 1903, the Zoological Park, as a whole, was greatly plagued by an enormous influx of rats. To everyone concerned with the work of the Bird Department these vermin were an intolerable pest, and were resisted vigorously, with poison, traps and guns. Ferrets were tried, but proved of no practical value. Finally the services of two rat-terriers were employed, and these proved effective. The Park, as a whole, is now as free from rats as such an institution can reasonably hope to be in a rat-infested city; but the warfare against these obnoxious creatures must necessarily be constant and vigorous. The wide distribution of grain throughout the Park, as used in feeding both mammals and birds, constitutes a perpetual attraction to vermin living around the Park, and, like stray cats, they continually pour in.

The following is a full statement of the bird collections on hand on December 31st, 1903:

ORDER.		SPECIES.	SPECIMENS.
Ratitae,	Ostrich and Cassowary . . . .	2	3
Longipennes,	Gulls, Terns, etc. . . . .	4	50
Steganopodes,	Pelicans, etc. . . . .	5	25
Anseres,	Ducks, Geese, etc. . . . .	34	240
Odontoglossae,	Flamingoes . . . . .	2	3
Herodiones,	Hérons, Egrets, etc. . . . .	14	71
Limicolae,	Shore Birds . . . . .	1	1
Paludicolae,	Cranes, Rails, etc. . . . .	8	17
Gallinae,	Upland Game Birds . . . . .	21	116
Columbae,	Pigeons and Doves. . . . .	5	5
Raptores,	Hawks, Eagles and Owls. . . .	19	57
Psittaci,	Parrots, Macaws, etc. . . . .	20	28
Passeres,	Perching Birds . . . . .	40	90
<hr/>		<hr/>	<hr/>
13 Orders . . . . .		175	706
Received by gift . . . . .			81
Purchased . . . . .			228
Exchanged . . . . .			6
Received on deposit. . . . .			2
Collected . . . . .			93
Hatched . . . . .			136

## DEPARTMENT OF REPTILES.

Among the important additions to the Reptile collection during the past year were two large specimens of the South American bushmaster (*Lachesis mutus*), representing the largest known species of poisonous serpent; an anaconda, measuring fourteen feet in length; three specimens of the *Boa constrictor*; two specimens of the *Boa diviniiloqua*; a large Indian rat snake, and two particularly fine specimens of the spectacled cobra (*Naja tripu-dians*). The cobras are strongly marked by the characteristic colors of their species. By their fierce demeanor, and hoods expanded for the slightest provocation, they attract much attention. These specimens were captured in the vicinity of Calcutta, and were presented by Mr. Thomas H. Barbour.

During the early summer, one of the Sumatran cobras evinced a cannibalistic appetite by swallowing one of its cage-mates. Promptly upon the discovery of the incident, the distorted snake

was taken from its cage, and by reaching down its throat with a pair of long forceps the curator was enabled to extricate the smaller cobra. The victim exhibited signs of life, but only survived for a few moments. This specimen was mounted in formalin, with hood spread, in the attitude assumed by the cobra when about to strike, and hardened in that position.

The big Ceylonese monitor, which has long been an important member of the collection of lizards, was so inconvenienced by an abnormal growth during the summer that it refused all food, and fasted for two months. Curator Ditmars operated on the reptile, which rapidly recovered, and its energetic and amusing egg-eating exhibitions are again a feature of the Reptile House.

As is usual in a large collection of reptiles, eccentric and dormant appetites are always to be cultivated. During the year several of the big snakes were fed at regular intervals in a compulsory manner, and one of the Sumatran cobras was subjected to the process of having three beaten eggs forced down its throat every ten days.

During the summer months, over two hundred terrapins, representing four of the larger species, were liberated in the various ponds of the Park, for the purpose of establishing an exhibit of these creatures in a partially wild condition, and at the same time to provide more living inhabitants for those small bodies of water. They soon made themselves quite at home, and on sunny days could be seen basking on the edges of the ponds, or upon rocks and other objects projecting above the water.

The condition of the collection of reptiles and amphibians on December 31st, 1903, was as follows:

Chelonia .....	32 species.	212 specimens.
Crocodylia .....	2 "	30 "
Lacertilia .....	13 "	77 "
Ophidia .....	40 "	218 "
Amphibia .....	12 "	125 "
—	—	—
	99 "	662 "

Received by gift.....	126
Purchased .....	262
Born .....	174
Used for food, for snake-eating snakes.....	275

210 turtles were purchased for distribution in the Park ponds.





VICUÑA.



PHOTOGRAPHS.

ELWIN R. SANBORN.

ALPACA.

From the collection of Cameloid animals presented by Mr. Robert S. Brewster.



## SUMMARY OF LIVE ANIMALS ON HAND ON JANUARY 1, 1904.

Mammals .....	153	species.	536	specimens.
Birds .....	175	"	706	"
Reptiles .....	99	"	662	"
		<hr/>		
Total .....	427		1,904	

## DEPARTMENT OF ADMINISTRATION.

During the year 1903 the facilities of the Department of Administration were increased by several noteworthy items of construction. A new soda-water pavilion and candy stand was erected near the Bear Dens, commodious in size and convenient in arrangement. During the busy season a cashier was employed for each soda-water pavilion, and the volume of business transacted was very satisfactory. The net profits on the sale of soda water and candy amounted to \$3,113.86, which was paid over to the Animal Fund.

*Abattoir.*—In order to diminish the quantity and cost of meat purchased for the carnivorous animals, a properly equipped abattoir was erected in connection with the service yard, for use in providing horse-meat. It may be of general interest to state that in many zoological gardens, horse-meat, derived from animals that have passed veterinary inspection, and which is known to be free from disease, is regularly fed to the large feline animals, and is very acceptable to them. In view of the present high prices of beef, it is imperatively necessary that this measure of economy be practiced in the Zoological Park. The horse-meat that has been supplied to the Lion House since the erection of the abattoir costs about one and one-half cents per pound, and is quite as satisfactory food for the animals as beef at five times that price.

*Wagon Scales.*—A much-needed addition to the equipment of the service yard has at last been installed at the west end of the service building. Platform scales for the weighing of coal, hay, grain and other supplies purchased in large quantities, have been purchased and placed in position, and now all the supplies mentioned are weighed as they are received.

*Women's Rest Room.*—Early in the year a rest room, specially designed for ladies, and children accompanying them, was suitably furnished and opened for use in the northwest corner of the Lion House, with an attendant in charge. This has proven very

acceptable to visitors, and has been well utilized. It is a satisfaction to be able to report that thus far the room has been treated by visitors as if the benefits it confers were gratefully appreciated. It is of special utility to ladies who, through excessive fatigue or sudden illness, require a retiring room with couches and easy chairs, and such attention as a female attendant can bestow.

*Exhibit at the Sportsmen's Show.*—Under the direction of Chief Clerk Mitchell, the Society placed an exhibit of photographs, drawings, specimens and publications at the Sportsmen's Show, held at the Madison Square Garden at the end of the winter of 1903. This exhibit was constantly attended, by Mr. Mitchell, Mr. Sanborn, and others, and the attention which it attracted to the objects of the Zoological Society resulted in the acquisition of about sixty new members.

*Publications.*—During the year a Souvenir Book of twenty Zoological Park photographs, reproduced by the Albertype process, was prepared and placed on sale. Although it was not offered to the public until late in the year, its sales showed, up to the end of the year, a profit of \$218.15. About the same time a series of souvenir postal cards, illustrating the Zoological Park, was prepared and placed on sale, and up to the close of the year yielded a net profit of \$130.14.

*Gate Receipts.*—The gate receipts for the past year show an increase of 38 per cent. over those of 1902. The total for 1903 was \$5,912.95, an increase of \$1,656.45 over the amount of the previous year.

*Rocking-Stone Restaurant.*—The Restaurant service was continued under the same system of management as had proven satisfactory in 1902. While no profit accrued to the benefit of the Animal Fund, a net loss of \$758.95 entered up on January 1, 1903, was at the end of the year converted into a profit of \$89.83. In addition to this there was effected a reduction in the obligations due the General Fund of \$150.00, besides the purchase of furniture and fixtures during the year to the amount of about \$500.00. Thus it will be noted that an actual gain of \$1,500.00 has been made in the operations of the Restaurant during the year 1903. A considerable increase in the amount of business can safely be expected during 1904, which, if realized, will put the Restaurant on a paying basis, and make it a regular annual contributor to the Animal Fund.

## DEPARTMENT OF PHOTOGRAPHY AND PUBLICATION.

The Zoological Park photographs which have appeared in the quarterly numbers of the Bulletin, and in the present volume, constitute ocular proof of the valuable and constant work of Mr. Sanborn in photographing the animals and buildings of the Zoological Park. The photographic records of rare animals that are constantly being secured are of great value to the general purposes of the Society. In a comparatively short time the Society will be able to publish a series of popular monographs, which will serve as an additional demonstration of the value of such photographic records as are now being made. Every rare animal that reaches the Park is photographed as soon as circumstances will permit, and the Society has always exercised toward the public, in the matter of reproducing its pictures, the greatest liberality consistent with its own interests.

Mr. Sanborn's admirable editorial work on the publications of the Society is fully appreciated by those for whom it is specially intended—the members of the organization. An extensive exhibit of enlarged photographs will be made at the Sportsmen's Show which is to be held in Madison Square Garden in February, 1904.

## DEPARTMENT OF ENGINEERING.

During the past year the civil engineer of the Zoological Park, Mr. George M. Beerbower, took up and carried through to completion the very important task of preparing the plans and specifications for all work in connection with the yards, walks and drainage surrounding the Antelope House, and also of acting as supervising engineer of the work.

It was considered inexpedient to attempt to plan these intricate improvements until the Antelope House had been erected. Immediately upon the opening of spring weather the necessary surveys of the site surrounding the Antelope House were made. The task which presented itself was one which involved serious difficulties, chiefly due to the irregularities of the surface of the hill to be covered with metal fences, the presence of a great number of trees that could not be disturbed, and various outcroppings of rock. All problems, however, were successfully worked out and embodied in a contract for fences and gates of structural steel, wrought iron and wire, which finally was awarded at a

cost of \$8,713.00. The execution of the work planned by Mr. Beerbower has satisfactorily demonstrated the correctness of his plans, and the finished work has received the approval of the Executive Committee. The fences erected are of three patterns, all new to the Park, and all gates and fastenings, also, were especially designed for the service they now render.

The total work involved in connection with the Antelope House fences, yards, drainage and walks occupied the attention of our engineer for a considerable portion of the year reported upon.

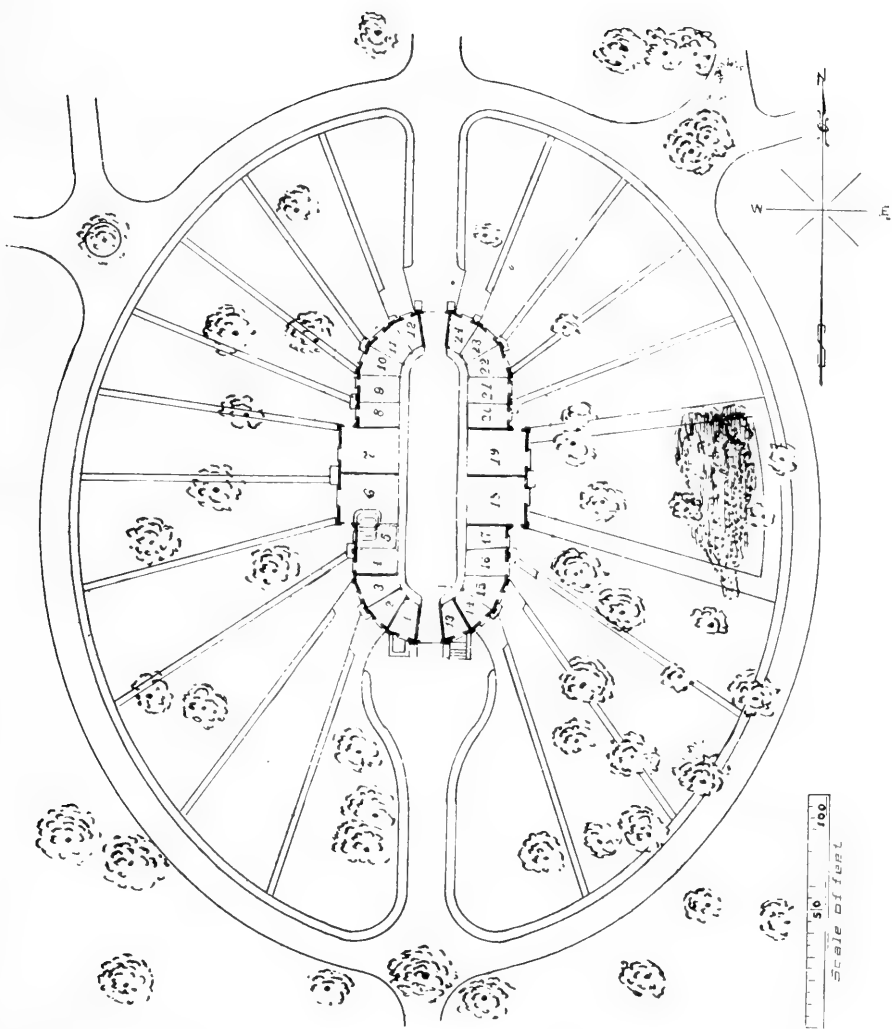
Mr. Beerbower has successfully designed a handsome and substantial fence of wrought iron to enclose the sea-lion pool on Baird Court. His plans for this improvement have been approved by the Executive Committee and Park Commissioner, and a contract for the work is to be advertised forthwith.

The improvement of the surface of Baird Court is proceeding under the joint direction of the Society's engineer and chief constructor. Mr. Beerbower's plans for the drainage of Baird Court have been carried into effect under his supervision, and the western retaining wall is now being raised to its full height. In addition to the above, Mr. Beerbower has prepared plans and specifications for the winter shelter and animal hospital in the animal yard, for the abattoir and stable connected with it, for the soda water and candy pavilion, for proper coal chutes for the large animal buildings, for the Bear Dens, and the preliminary plans for the large Deer Barn and yards surrounding it.

#### GROUND IMPROVEMENTS.

The operations of the ground improvement force, under Mr. Hermann W. Merkel, chief constructor, have been unusually varied and important. A list of the most important work performed by this force during the year 1903 includes the following:

The Antelope House yards, drainage and surrounding walks; the drainage of Baird Court; construction of the Llama House, candy pavilion, animal shelter and hospital, deer shelter for fallow deer range, deer shelter for sika deer range; water supply and drainage to Italian fountain; construction of abattoir and stable adjoining; construction of rock-work in three outside cages of Lion House; construction of concrete wall around Prairie Dog Village, and the erection of a great number of new fences for animal enclosures. During the working months of the year three separate forces of mechanics and laborers, skilled and unskilled,



GROUND PLAN: ANTELOPE HOUSE AND YARDS.





were employed on these tasks, and work was pushed forward with the utmost vigor. A few of these items are well worthy of special mention:

*Antelope House.*—The series of twenty-three yards surrounding the Antelope House form a very extensive feature of this installation, and from the first their development was recognized as a matter involving much difficult work and very considerable expense. Owing to the peculiar nature of the site, it early became apparent that it would be desirable to let a contract for the fencing, gates, etc., and have all filling, grading, macadamizing, post-setting and concrete work performed under the immediate supervision of Zoological Park officers. By the consent of the Park Commissioner this plan was adopted and has been carried out, and by reason of the possibility of meeting certain conditions as they were found, the best results possible have been secured with the least possible expenditure.

The outer boundaries of the two series of yards consist of a heavy wrought-iron fence, eight feet high, standing over concrete coping. The divisions between the yards consist of two double lines of the heaviest Page wire fencing, set on steel posts three feet apart, partly for the purpose of giving valuable space for planting, and partly to prevent horned animals from fighting through the partitions and injuring each other. The fence for the elephant yard has been constructed of heavy angle-irons and tee-irons of several patterns, each post being very firmly braced on the outside. All the yards have been paved with telford macadam, and fully provided with valleys, catch-basins and underground drains. By means of a series of gates near the building, it is possible for service carts to drive entirely around the building near the outer wall, for the purpose of collecting refuse.

With the exception of the Bear Dens, this outdoor improvement has been the most extensive of its kind that has yet been made in the Zoological Park. A contract for the fencing was awarded to the Page Woven Wire Fence Company, of Adrian, Michigan, and has been filled with promptness and scrupulous care, with materials that are highly satisfactory. The extent of the yard accommodations, and the cost of their construction, may be appreciated from the fact that their total frontage is 1,392 feet. If laid out in a straight line, the yards of the Antelope House would extend in an unbroken series from the north door of the building to the Boston Road Entrance, and fifty feet beyond. If laid down upon Baird Court, this improvement, as a whole, would cover practically the entire southern portion of that

area up to Sea-Lion Pool. As an index of the extent of the task recently completed, the following figures are offered:

Dimensions of area treated.....	335 x 387 feet.
Length of concrete wall and coping.....	1,392 "
Lineal feet of heavy wrought-iron fence, 8 feet high.	1,392 "
Lineal feet of elephant fence.....	276 "
Lineal feet of extra heavy wire fencing.....	3,424 "
Wire gates .....	38
Heavy wrought-iron gates.....	25
Extra heavy gates of steel beams.....	2

In addition to the construction of the yards around the Antelope House, a twelve-foot walk was built to encircle the whole, and render the twenty-three outdoor enclosures available to visitors. The necessary elevation of the northern portion of this encircling walk renders it necessary to expend about \$500.00 in connecting it with the Mountain Sheep Walk and one other.

*Cleaning Ironwork of Bear Dens.*—The four new Bear Dens which were to have been completed in 1902, were not completed until the late spring of 1903. The final occupancy of the new dens at last rendered it possible to transfer bears from the old dens for the purpose of putting those enclosures into thorough repair. It was found necessary to purchase a sand-blast, in order to free the ironwork of the rust which had accumulated upon it and paint it in such a manner that the rusting of the metal would be effectually stopped. It has been found that the salt air of the Zoological Park causes all fences and exposed ironwork to accumulate rust at an alarming and almost unprecedented rate. It has been found that unless structural steel and wrought-iron work exposed to the weather has been cleaned of all foundry scales by the sand-blast process, it is an impossibility to paint the metal in such a manner that rust will not take hold under the foundry scales and greatly damage the material. For this reason all recent contracts for ironwork in the Zoological Park have called for the strictest precautionary measures calculated to avoid rust. Every particle of ironwork in the original series of bear dens is now being gone over with the sand-blast, in order to arrest the ravages of rust, and prevent damage from that source in the future. This grave and imperative necessity applies to all structural ironwork exposed to the weather in the Park, except wire netting, and the cost involved has already made a serious inroad upon the Maintenance Fund.



A SECTION OF THE NEW BEAR DENS.  
Showing the rock-work sleeping quarters.



PHOTOGRAPHS.

ELWIN R. SANBORN.

THE LLAMA HOUSE.  
For the llamas, alpacas, guanacos, and vicunias.



*Llama House.*—Early in 1903 the Zoological Society received from Mr. Robert S. Brewster, as a gift, a complete collection of the cameloid animals of South America, embracing the llama, guanaco, vicuna and alpaca. To provide suitable quarters for this handsome gift, the Society erected, at the expense of the Ground Improvement Fund, a building now known as the Llama House, situated near the Southwest Entrance to the Park. This building is 30x35 feet, and is one story in height. It contains four spacious shelter rooms, a feed-room, and connects directly with four outside yards of good dimensions. This structure was built of wood, at a cost of \$2,000.00, and is in every way so substantial that it will keep in repair for a long period.

*Outdoor Cages of Lion House.*—As early in the year as weather would permit, work was begun on the construction of the rustic rock-work in the interiors of the three largest outside cages forming a part of the Lion House. A great amount of trouble was experienced in collecting an adequate supply of weathered rock for the artistic structures required, the idea being in each case to reproduce what appears to be the end of a rocky ridge. This work was prosecuted vigorously throughout the summer, and completed in October; but the wall decorations designed for each rear wall of the three cages mentioned are yet to be executed.

*Riverside Walk.*—The walk extending along the eastern side of Bronx Lake, from West Farms to Bronxdale,—a total distance of 4,195 feet,—has been completed in a satisfactory manner, and adequately opens up to visitors the entire park area east of the Bronx.

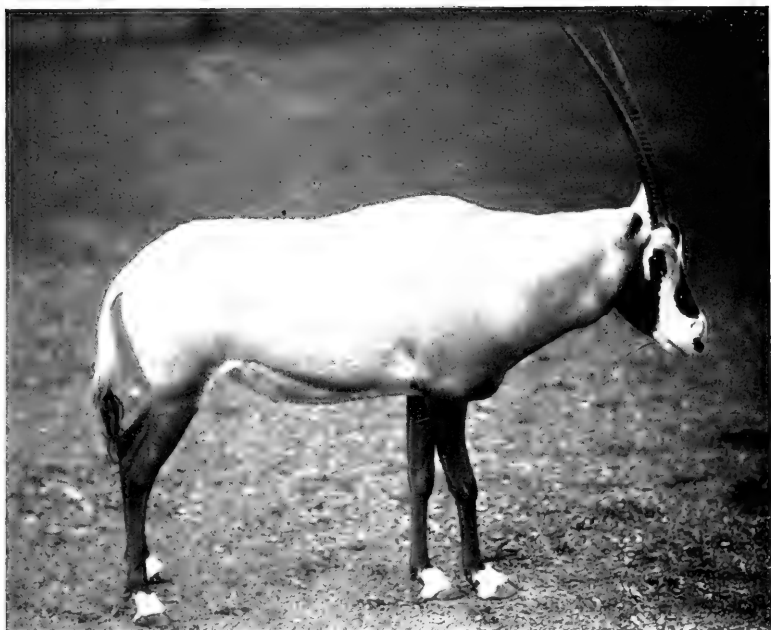
*Improvement of Baird Court.*—Late in the year the improvement of the southern half of Baird Court was undertaken by the construction of a complete network of drains and catch-basins for the adequate drainage of the surface. The western retaining wall of Baird Court is now being raised to the full height of the finished grade, and at an early date this wall will receive its facing and coping of cut stone, surmounted by a balustrade, and permanent steps will be erected leading from Bird Valley to the center of Baird Court. A large quantity of stone has been accumulated on Baird Court for the foundation of the telford macadam pavement that will be laid early in the spring. Experiments with tar as a surface-binder were undertaken, and it is hoped that a combination can be found which will render it possible to provide a smooth, hard surface for the telford macadam.

## MISCELLANEOUS GROUND IMPROVEMENT WORK.

Even the briefest mention of the miscellaneous ground improvement work performed during the year 1903 would make a long list, and for the sake of brevity will be omitted here. It is desirable, however, to mention the fact that the planting operations included the planting of 2,063 trees in the border plantations of the Park.

The temporary Small Mammal House erected by the Zoological Society at its own expense, was removed from its original location and re-erected in the Nursery as a hot-house, it having been originally intended that it should finally be used in that manner. This adds a very important feature to the Nursery plant. The removal of this building, and the acquisition of large herds of buffalo and elk, rendered it imperative to provide a winter shelter for miscellaneous animals not on exhibition yet requiring some artificial heat. A substantial and permanent shelter was erected in the northwestern corner of the animal yard, and provided on all four sides with stalls and cages for the accommodation of animals which live outdoors in summer, but require a temperature of sixty degrees in winter. The completion of this feature rendered it possible to devote the entire shelter portion of the Buffalo House to the Whitney herd, and the main shelter of the Elk House to the Whitney elk herd. Heretofore both those buildings have been occupied in winter as temporary shelters for tropical hoofed animals.

*Lydig Memorial Gateway.*—The fact that for fully three-quarters of a century the Lydig family carefully preserved the forest of south Bronx Park, and in so doing rendered a conspicuous service to the City of New York, has long been considered by the Zoological Society worthy of permanent commemoration. In these days of forest destruction such an example has seemed well worthy of public notice, in the hope that its influence will bear fruit in the future for the benefit of other cities. The offer of Mrs. Lydia Lydig Sturgis to erect in Zoological Park a memorial gateway in commemoration of the preservation of the surrounding forest by the Lydig family, was promptly accepted by the Zoological Society. A very handsome gateway, or arch, consisting of two massive pillars of cut stone, surmounted by an arch of ornamental wrought iron, was erected at the expense of Mrs. Sturgis at the top of the steps leading from the Buffalo Entrance to the upper level of Rocking-Stone Hill. On the eastern



PHOTOGRAPH.

ELWIN R. SANBORN.

BEATRIX ANTELOPE.



PHOTOGRAPH.

ELWIN R. SANBORN.

BLESSBOK.





face of these pillars two bronze tablets, explanatory of the cause of their erection, have been affixed. It has, from the first, been the plan of the Society to bring about the construction at that point of a handsome flight of steps of cut stone, with suitable balustrades, which, when carried into effect, will render this feature sufficiently beautiful to impress every visitor who enters the Park from the Boston Road by way of West Farms.

*Maintenance.*—The fact that the Maintenance appropriation for the year 1904 is no larger than that which has been barely sufficient for the present year, creates a serious condition. The increase already made in maintenance expenditures on account of the Antelope House and its collections and the Whitney buffalo herd, and the increase which must be made next year on account of the Ostrich House and Small Mammal House, will call for expenditures very considerably in excess of those for the present year. In view of the close economy which has been necessary to carry the Park through the year 1903, with its Maintenance appropriation of \$104,965.00, it is painfully apparent that the Society will be compelled to face a deficit for 1904.

#### WORK DURING THE COMING YEAR.

In the making of new improvements, the developments of the year 1904 promise to be of great importance. The successful ending of the work recently begun will bring the Zoological Park about three-quarters of the way toward practical completion.

*Large Bird House.*—On September 22d a contract was entered into with the George L. Walker Company for the erection of a large and finely appointed building for perching birds, to be situated on the northwest corner of Baird Court. The contract price is \$115,934.00. The object of this building is to provide both indoor and outdoor accommodations for a really great collection of birds belonging to the three Orders of Perching Birds, Shore Birds and the Parrots and Macaws. The extreme length of this building, north and south, is 151½ feet, and the extreme length of the cross-extension toward the east is 89 feet. The total number of cages, indoors, is 59, besides which there are 19 outside cages. This building is divided into two halls, one of which will be specially devoted to the parrots, parrakeets, macaws and cockatoos, while the other and larger hall will be devoted chiefly to the singing birds. The larger hall will contain a flying cage of generous dimensions, which will be specially devoted to song birds.

This building is now receiving its base course of granite, and

with the opening of spring its construction will proceed very rapidly.

*Small Mammals' House.*—On the site of what was until recently the temporary Small Mammals' House, there is now being erected a building 170 feet long, specially designed to accommodate a very large mixed collection of small mammals. The majority of the cages will be occupied by carnivorous types, but there has also been provided a number of larger cages suitable for kangaroos and various other tropical mammals of medium size which cannot be accommodated elsewhere. In addition to the indoor cages there is a complete series of outdoor cages corresponding to those within, and directly connecting therewith. The total number of cages is 114. The cost of this building is \$36,890.00.

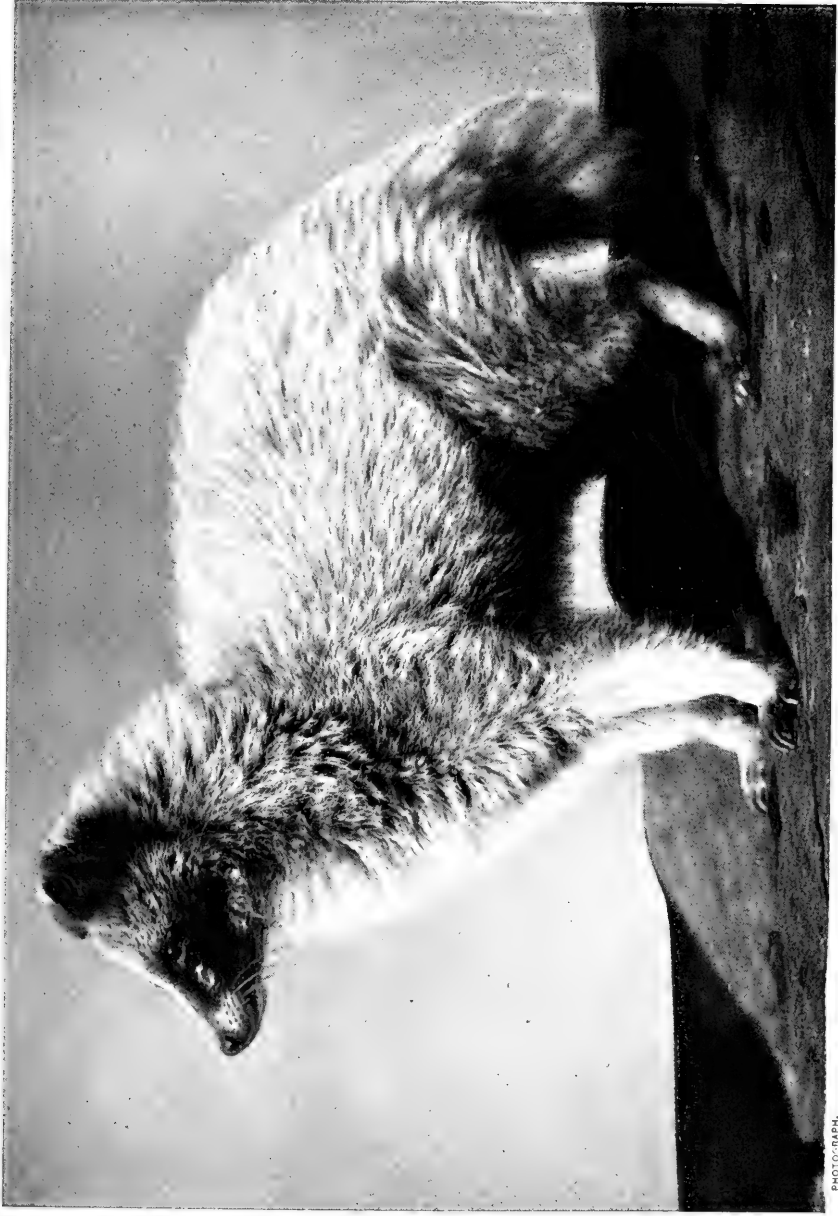
*Ostrich House.*—For the accommodation of a large collection of ostriches, rheas, emus and cassowaries, a building of the same dimensions as the Small Mammals' House is being erected immediately south of the latter, and the two are connected by a spacious portico. The cost of this building is \$36,890.00, and both it and the Small Mammals' House are included in one contract, made on July 23d, 1903, with the George L. Walker Company.

*Large Deer Barn.*—In order to provide for several large and important foreign species of deer, a large Deer Barn is being erected at the intersection of the ranges now occupied by the maral deer and fallow deer. These three ranges are to be remodelled in such a manner that accommodations will be provided for five more species of deer, in addition to the present herds. All these herds will then find shelter in the new structure. With the completion of this improvement, the Society will procure herds of Dubowsky's deer, barasingha, deer, Eld's deer, and other species of special importance.

Respectfully submitted,

WILLIAM T. HORNADAY,  
*Director.*





ELWIN R. SANBORN.

WHITE RACCOON DOG (*NYCTEREUTES ALBUS*).

PHOTOGRAPH.

## A NEW SPECIES OF RACCOON DOG.

By WILLIAM T. HORNADAY.

IN November, 1902, the New York Zoological Society received from Captain Thomas Golding, of the steamer "*Afridi*," a collection of about twenty live animals from Japan, China and Singapore. In the collection was a small white animal which bore a slight resemblance to an immature Arctic fox, and which up to its arrival had been called a "White Fox." It was obtained by Captain Golding in Nagasaki, Japan, of a native dealer in live animals, who was unable to give its history, and could only state that it came from the northern portion of Japan.

It was at once apparent that the creature was not a fox, and also that it represented a species which at the least is very rarely seen in captivity. An examination of its external characters revealed an unmistakable resemblance to *Nyctereutes procyonoides*, the raccoon dog, of Japan and north China. Inasmuch as the animal appeared to be immature, and it seemed possible that its pelage might undergo seasonal changes of some importance, it was decided to defer bringing it into notice, and keep it under observation for at least a year.

During the fifteen months which this strange specimen has lived in the Zoological Park, it has not undergone any noteworthy change in pelage, nor has it perceptibly increased in size. It therefore seems fairly conclusive that the creature is adult, and that its colors are constant throughout the year. It is not an albino individual of the well-known raccoon dog referred to above, with living specimens of which it has been in constant comparison. There appears to be no escape from the conclusion that this specimen represents a species hitherto unknown, and it is quite time that it should be described.

NYCTEREUTES ALBUS, sp. nov.

WHITE RACCOON DOG.

No. 1371. *Type*, an adult female, obtained alive at Nagasaki, Japan, by Thomas Golding, and living in the New York Zoological Park from November 21st, 1902, to date (February 15th, 1904).

*Form.*—In general appearance this animal resembles a sharp-nosed raccoon (*Procyon lotor*), even more than its nearest relative, *Nyctereutes procyonoides*. Its back is highly arched, its head is carried rather low, and its tail has a very raccoon-like droop. The feet are small and delicately formed, and the front feet in particular are short and weak. Although the claws are long, they are slender, remarkably straight, and have little strength, either for offense or defense. The ears are short, and in shape most nearly resemble those of the arctic fox. As a whole, this animal is not physically robust, nor is it vicious in temper. On the contrary, it has taken kindly to its keepers and captivity. Its teeth are small and weak, and it is poorly equipped for self-preservation. It requires a home that is not overrun by bears, wolves, foxes, or the larger members of the Family *Mustelidae*; and very probably it inhabits moist lowlands, rather than dry and rugged mountains.

*Colors.*—Excepting upon the feet and lower half of the legs, the pelage is like that of a small arctic fox (*Vulpes lagopus*). The entire neck, body, legs, feet and tail are pure white. On each side of the head is a large and conspicuous triangular patch of blackish-brown hair, of which the eye is the culminating point, suggestive of the dark cheek-patch of the common raccoon. From the eye, this dark patch extends backward over the lower half of the cheek, and forward along the side of the muzzle two-thirds of the distance from the eye to the end of the nose. The top of the muzzle is white, and the upper lip shows a light-colored blending of brown and white. The forehead is white, but the side of the head, between the ear and the dark cheek-patch, is a dusky mixture of white and brown hairs.

The ear is conspicuously dark, the edge being quite black. The back of the ear is light brown, but the interior is partly filled with long, light-colored hairs.

*Pelage.*—On the neck, body, tail and thighs the pelage is dense and fine, and consists of two coats. On the upper surface the inner coat is very fine and woolly, and about one inch long. The outer coat is two inches long, straight, and of coarser texture, as is usual in a rain-coat. The hair on the tail is abundant, but ends abruptly at the tip, like a tail artificially shortened. The pelage on the lower half of each leg is exceedingly scanty. The feet are very thinly haired, as if this creature had been specially fitted for life in swamps and tundras, where frequent wading in water is necessary. The claws are long, slender, white or pinkish. On the abdomen the pelage is about one-half the length



WHITE RACCOON DOG.



PHOTOGRAPHS.

WHITE RACCOON DOG.

ELWIN R. SANBORN





of that on the upper surface, and consists chiefly of the fine, woolly under fur.

*Dentition.*—The teeth are small and weak, much smaller than in *Nyctereutes procyonoides*, and of not more than one-half the size and strength of those in *Vulpes lagopus*. As nearly as could be ascertained by an examination of the teeth of the living animal, the dental formula is as follows:

$$\text{Incisors } \frac{3-3}{3-3}; \text{ Canines } \frac{1-1}{1-1}; \text{ Premolars } \frac{3-3}{3-3}; \text{ Molars } \frac{3-3}{3-3}$$

#### MEASUREMENTS.

Length of head and body.....	21.00 in.
Tail to end of vertebrae .....	6.25 "
Tail to end of hair .....	8.00 "
Height at shoulders .....	10.25 "
Girth, behind fore legs.....	14.00 "
Length from inner corner of eye to end of nose..	2.25 "
Distance between inner corners of eyes.....	1.37 "
Distance between inner corners of ears.....	3.00 "
Height of ear .....	1.50 "
Length of fore foot to end of middle claw.....	1.50 "
Length of middle claw, exposed.....	.50 "
Length of hind foot, to end of longest claw.....	4.50 "
Length of eye-opening .....	.50 "

Pupil, round; color of iris, dark brown.

End of nose, black.

Weight, 7½ pounds.

*Nomenclature.*—In his "Monograph of the Canidae," Mr. St. George Mivart not only discards the genus *Nyctereutes*, but also the genera *Vulpes* and *Urocyon*, and throws all their members, pell-mell, into *Canis*! The very least that can be said of such a proceeding is to call it remarkable. To the average student of living mammals it would seem that if generic groups ever are convenient and desirable, and also fully justified, *Vulpes*, *Urocyon* and *Nyctereutes* are entitled to stand; and the very appropriately-named genus proposed by Temminck, in 1838, for the raccoon-like dog of North China and Japan, is retained for the species described above.

## REPORT OF THE DIRECTOR OF THE AQUARIUM.

**D**URING the year that has passed since the Zoological Society undertook the management of the Aquarium, important improvements have been made in the building and its equipment.

Its conditions and requirements have had the careful consideration of the officers of the Society. The Director, as a result of his studies among the public aquariums abroad, prepared plans for increasing the efficiency of the equipment of the building, and has had the hearty cooperation of the Aquarium Committee.

The alterations and additions that have been made were directed toward increasing the attractiveness of the Aquarium and securing the safety of its exhibits. While much remains to be done, the idea of simplifying the machinery and reducing the ultimate cost of operation has been kept in mind.

The renewal, on improved plans, of all badly worn equipment is still in progress.

### IMPROVEMENT OF THE BUILDING.

With the \$30,000 of bonds granted by the Board of Estimate and Apportionment in the spring of 1903, contracts were made for certain alterations and improvements of the interior of the building, the admission of more light and the construction of an underground reservoir to contain pure sea water. The alterations included the removal of an unsightly balcony at the south side of the exhibition hall and the restoration of the original curve of the interior, the passage-way being thrown *behind* the arches, as in other parts of the main balcony.

*Light.*—The outer series of skylights used for the illumination of the wall tanks were trebled in size. Additional skylights were placed above the dome, and those over the floor pools were enlarged. The opening in the dome for the admission of light was also greatly enlarged. In all, 42 skylights were changed.

These changes have long been needed, and the gain in light is such that the collections in the tanks may be viewed with satisfaction.



NEW ROCK-WORK AT THE N. Y. AQUARIUM.

The white tiles in the wall tanks are being replaced by different kinds of rock lining.



The large floor pool in the center of the building can now be provided with attractive exhibits. Heretofore it has been too dark to permit of its contents being seen, except on the very brightest days. There is now no reason why it should not contain some of the large-sized marine animals, for which it was intended.

It should be borne in mind that the perfect lighting of the Aquarium is a matter of considerable difficulty. The building is an old fort, with walls 8 to 10 feet thick, in which it is impracticable to make alterations. The light in the lower wall-tanks being derived entirely from lofty skylights, is still somewhat like the light at the bottom of a well.

*Reservoir for Sea-Water.*—The pressing need of the Aquarium has always been pure sea-water. The collection of sea animals has suffered from being kept in the brackish or nearly fresh water of New York Bay, which has always been used. Not only has the loss of marine specimens been great from their being kept in water that was too fresh, but the exhibition of many marine animals has been quite impossible, for the same reason. A still greater objection to its use is its muddiness during the winter months. The constant heating of water in winter has always been very expensive. With a suitable reservoir four important objects will be attained: first, clear instead of muddy water; second, salt instead of brackish water; third, the exhibition of new forms; fourth, the saving of heated water.

The construction of a reservoir has been undertaken with considerable hesitation, as the Aquarium has no basement and it is necessary to locate the reservoir in the Park adjacent to the building, placing it entirely underground. This is a difficult matter, as the tide at the adjacent sea-wall rises considerably above the floor of the reservoir, making its position, on account of the lifting power of the tide, a rather unfavorable one.

There will probably be no difficulty in filling the reservoir with pure water, as numerous steamships come to New York with sea-water in their water-ballast compartments.

This reservoir or closed-circulation system is the one commonly used in the public aquariums of the world.

In the table of temperatures and densities presented elsewhere, the mean temperature is shown for each month. While the average for February was 37°, it was frequently as low as 35°. The energy expended in raising the water temperature to the necessary warmth of 70° is considerable. The waste is a continuous one. As there is no reservoir for receiving the warm water, it has always flowed back to the Bay. The completion of the reser-

voir now in course of construction will enable the Aquarium to maintain a permanent stored supply of pure salt water, such as can never be procured from New York Bay at any season.

#### OTHER IMPROVEMENTS.

Among the minor improvements, may be mentioned the addition of a number of reserve tanks, so that it will be possible to keep a larger stock of specimens on hand; the introduction of seats around the pillars, the painting of the exhibition hall, laboratory and offices.

The improvement most apparent to visitors is doubtless the painting of the interior. This work was imperative, as the original plaster finish had become soiled and unsightly.

The change effected by painting has been quite marked, and an attractive setting to the exhibits of the Aquarium, has been secured.

The renewal of some of the piping in the building has been made at different times during the year. It has been both troublesome and expensive.

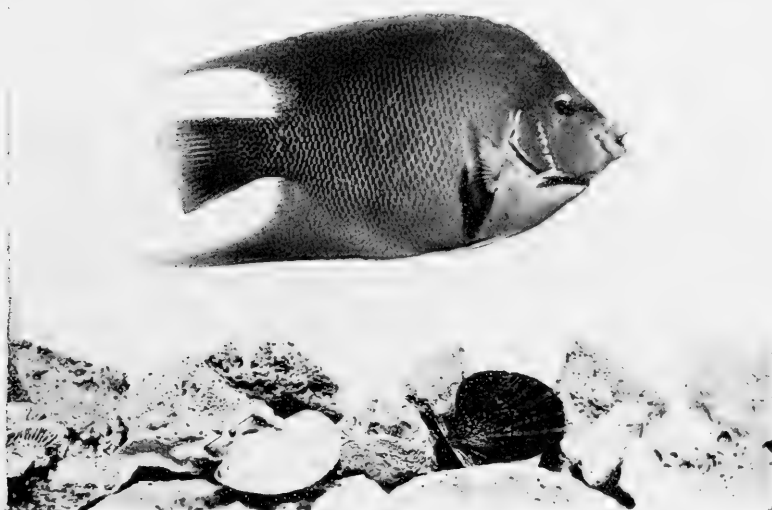
*Improvements Needed.*—While there are many changes and improvements that are desirable, the most important and urgent one is the renewal of the heating system and probably of the steam pipes, which cannot be delayed longer than a few months.

*Fish Hatchery.*—At the beginning of the year a fish hatchery was installed in one of the floor pools. Through the cooperation of the United States Fisheries Bureau and the State Fisheries, Game and Forest Commission, the hatchery was kept in operation at a minimum of expense throughout the fish-hatching season. Fish eggs were furnished free by the Government, while the young fishes were removed by the State Commission. More than 2,000,000 fry were distributed in State waters. Many specimens of each species hatched were retained to be reared for exhibition in the Aquarium, as such stock is hardier in captivity than adult fishes taken from streams.

The species hatched and distributed included brook trout, lake trout, brown trout, rainbow trout, whitefish, shad, pikeperch and yellow perch. The shad were all placed in the upper Hudson; the balance, with the exception of the brown trout and yellow perch, were planted in Lake George; the eggs of the brown trout having been presented by the Tuxedo Club, the fry were donated to members of the Zoological Society; the yellow perch were used for stocking the lake at the Zoological Park, with a view to raising food for fish-eating birds and mammals.

The hatchery afforded a practical working exhibit of the processes of modern fish culture and was of constant interest to visitors. School teachers visiting the Aquarium with their classes found it useful for biological instruction. It should doubtless be developed into a local school of fish culture, and can supply embryological material for advanced students in the universities.

Arrangements have been completed for continuing the hatchery on the same basis during the coming year, and eggs of the Quinat Salmon of the Pacific Coast have already been placed in it.



PHOTOGRAPH.

H. V. LETKEMANN.

ANGEL FISH.

*Rock-work in the Exhibition Tanks.*—During the past year nearly one-half of the exhibition tanks at the Aquarium have been lined with rock-work, in order to exhibit the specimens with more natural backgrounds. This treatment of the tanks has proven satisfactory, and is an improvement on the original lining of white tiles, which gave them a very monotonous appearance.

A supply of coral rock was procured from the Bahama Islands, and an attempt has been made to give the tanks the appearance of grottoes like those occurring in the reefs about islands of coral formation.

A number of very good sea caverns have thus been constructed,

some being made of calcareous tufa obtained in New York State, and the effect of sea-worn rocks has been produced in some tanks with other material.

In the fresh-water tanks the problem has been somewhat more difficult, but an attempt has been made to reproduce the stony banks of streams with various kinds of rock.

A supply of basalt from the gorge at Little Falls, N. J., has been arranged in one of the larger tanks, in the exact position it occupied on the edge of the stream.

It is hoped, by the time this work is completed, that a series of under-water pictures will be worked out in such a manner as to greatly enhance the attractiveness of the exhibits at the Aquarium. Seaweed will be introduced into the salt-water tanks, and the fresh-water tanks will be decorated with fresh-water species of plants. Aquatic vegetation of various colors growing on the rock-work will also contribute largely to the interest of the exhibits. This treatment is beneficial to the animal life contained in them. The fishes appear to take an interest in exploring the crannies in the rocks, while star-fishes, crabs, and other invertebrates cling to them constantly.

A colony of ascidians is now propagating freely in one of the salt-water tanks, the rocks being covered with hundreds of young specimens. It will be possible to ascertain the rate of growth of many invertebrate animals in this way.

The observations already made tend to show that the species exhibited retain their natural colors better than when the tanks were lined with white tiles. After a few weeks the rock-work acquires various rich tones, which are agreeable to the eye of the visitor, and contribute to the comfort of the species exhibited.

The accompanying photograph will serve to convey an idea of the nature of the rock-work already in place.

#### THE WORK OF THE COLLECTOR.

In order that the local marine and fresh-water forms of life might be constantly on exhibition, a collector was added to the Aquarium force at the beginning of the year. The results secured thereby have been very satisfactory. Collections of salt-water fishes have been made constantly both in summer and in winter, while numerous trips for fresh-water species have been made to lakes and streams in the vicinity of New York.

The collector has always been able to contribute an important proportion of the minnows and other live food required for feeding the collections, while the surplus marine life gathered along



the coast has been placed at the disposal of the biology teachers in the city schools.

In addition to furnishing the large amount of seaweed used as food for the manatee, the collector has supplied all of the seaweed required for the decoration of the exhibition tanks at the Aquarium, and for the small study aquaria now being established in the public schools.

Some of the surplus exhibition material brought in by the collector has been sent to the aquariums of the Bureau of Fisheries and the Zoological Park at Washington, in exchange for valuable specimens from those institutions.

Donations of the large horseshoe crabs, of the American coast, were made to the aquariums at Brighton, Eng., and Amsterdam, Holland. These interesting specimens, not found in Europe, reached their destinations safely, to the great satisfaction of the recipients, who offered to exchange European species.

All interesting specimens dying in the New York Aquarium during the year were donated to the American Museum of Natural History, the Museum of the Brooklyn Institute, and the College of Physicians and Surgeons.

#### OTHER COLLECTIONS.

Arrangements were made during the summer with owners of some of the large pound-nets on the New Jersey coast for the collecting of a number of large fishes, not otherwise obtainable. For the transportation of these fishes, some of them weighing over 50 pounds, a "live car" was constructed out of an old boat, which, when loaded, was towed to the Aquarium by a steam launch.

Several good collections were received from the State fishery commissions of New York and New Jersey, and from the fish hatchery of the Tuxedo Club.

The Fisheries Bureau at Washington has not only furnished fish eggs for the hatchery, but has contributed quite a number of interesting adult fishes.

The accompanying list of accessions shows that many friends of the Society have contributed specimens during the year.

Arrangements were made with the steamer "*Angler*," which makes frequent trips during the fishing season, for the regular collection of large skates and other desirable specimens from the fishing banks off the New Jersey coast.

Mr. Henry Bishop, of Baltimore, presented 25 specimens of fancy goldfishes, representing several varieties. This is Mr. Bishop's *annual* donation to the Aquarium of a collection of this kind.

The usual collection of tropical fishes from Bermuda was secured through the New York University. Prof. Charles L. Bristol, of that institution, who went to the Bermudas in charge of the biological station of the University, collected the specimens, which were sent to the Aquarium as four different shipments in June, July and August. Specimens were procured of a large number of brilliantly colored species inhabiting those waters. A further collection of Bermuda fishes was received as a deposit by the Fisheries Bureau at Washington, the specimens being intended for the aquarium at St. Louis. These fishes, being simply deposited in the New York Aquarium for safe-keeping, will be sent to St. Louis in the spring. It is needless to state that they contribute greatly to the attractiveness of the tanks in the Aquarium at the present time.

The alligator pool having been divided by a partition, has been made more interesting by the addition of a 9-foot specimen of the Florida crocodile, affording the means of a ready comparison of the features of the two large saurians of the United States—the alligator and crocodile.

On September 3d a specimen of the manatee or sea-cow was received from Florida. It arrived safely, and was a great attraction for five months. This specimen,  $7\frac{1}{2}$  feet long, was the only manatee in captivity in this country at the time. It was seen by 526,700 people.

An 11-foot alligator was loaned to the Aquarium by the Zoological Society from its collection at the Zoological Park.

#### EDUCATIONAL WORK.

According to the contract of the Zoological Society with the city, the Society has the privilege of reserving two forenoons of each week for educational purposes, for the use of its members, and such other uses as may be prescribed. Teachers from the schools were invited to bring their classes at such times to the Aquarium, and they have not been slow to avail themselves of the privilege. The services of a member of the Aquarium staff have been placed at their disposal on such occasions and the number of classes visiting the building is on the increase.

The collection of small study aquaria in the laboratory has been increased with a view to facilitating their work. In the laboratory pupils have the opportunity of examining closely, living coral polyps, sea anemones, marine worms, hydroids, small mollusks, crustaceans and other forms that cannot be studied minutely in the large exhibition tanks. Lessons of this kind are of

the greatest value in nature study, in arousing the interest of the pupils, and are vastly more instructive than illustrations in the books.

In response to numerous requests from biology teachers for assistance in establishing small study aquaria in the school-rooms, an expert from the Aquarium was detailed to visit all schools making application, and give the teachers practical instruction in maintaining these valuable aids to nature study. The cooperation of the Board of Education was secured; the Board agreeing to supply the teachers with aquarium jars and transport to the schools the necessary supply of sea-water. The collections for these aquaria are furnished free from the surplus stock at the New York Aquarium. About 100 small aquaria have already been placed in schools, both teachers and pupils taking great interest in them. The number is being steadily increased as teachers make application for them. This work is in the hands of Mr. L. B. Spencer, of the Aquarium.

A small library of works on marine and aquatic life has been acquired for office purposes, and for the use of teachers and others studying the collections.

#### DENSITY OBSERVATIONS AT THE AQUARIUM.

The remarkable conditions under which sea fishes have always been kept at the Aquarium rendered it desirable that regular observations be made on the density of the water. Ocean salinometers were secured and the results of a year's observations show some very interesting conditions, especially with respect to fishes from the Bermuda Islands, where ocean densities are probably at their highest. While it is a fact that some of these fishes live in the Aquarium for months, and even for years, the majority of the species in each collection brought from that region do not survive many weeks.

Injured fishes, that have been bruised at the time of captivity and during transportation, frequently heal in a short time if the density of the water happens to be at its highest when they arrive at the Aquarium. Should the density be low, they are apt to die much sooner, as their injuries do not heal under such conditions. Should the Hudson River be high when new fishes, either tropical or local, are received, the mortality is apt to be greater than when the river is low. The highest death-rate among the sea fishes that the Aquarium has had for some time followed the heavy floods of the past summer. During the winter and spring the densities are much lower than in summer.

Sea fishes living in water of low density are affected in other

ways; their colors fade and they do not feed well. An increase in density has a good effect on the entire salt-water collection.

The following table, giving the monthly mean density of the water used at the New York Aquarium during the past year, will serve to show at a glance the conditions under which the salt-water fishes have been living there. With the density of fresh water at 1.000 and the density of the open ocean at 1.028, it will be seen that under average conditions the water was at least half fresh, while at times it became almost entirely so.

MONTHLY MEAN TEMPERATURES AND SPECIFIC GRAVITIES AT THE  
NEW YORK AQUARIUM DURING THE YEAR 1903.

(From the daily observations made by Mr. W. DeNyse.)

Months.	Temperature of water.	Specific gravity.
February .....	37	1.010
March .....	40	1.008
April .....	46	1.009
May .....	56	1.014
June .....	61	1.013
July .....	66	1.013
August .....	68	1.013
September .....	68	1.013
October .....	62	1.011
November .....	52	1.014
December .....	40	1.014

The above table shows only the monthly means. Observations were made daily. During the month of March the densities were frequently as low as 1.006, on one occasion reaching 1.005. The highest densities recorded during the year, were late in May and early in June, when the densities were steadily recorded at 1.016. The most trying times come in March, when for days the density may be 1.006 or 1.007.\*

It would be very interesting to determine just what freshness of water fishes from the Bermuda region could endure. A few hardy species have lived through all the changes that they have been subjected to, and are still in excellent condition.

*Labels.*—Transparent labels have been placed over all the wall tanks on the ground floor, and will be placed over those on the gallery at an early date. The labels are in good-sized letters and can be read with comfort. The information which they contain is useful and is condensed to a few lines.

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\* Density observations were made with samples of water brought to the uniform temperature of 60° Fahr.

In the preparation of these labels the general character of the questions ordinarily asked by visitors was kept in mind. The following specimen label shows that each species has been treated with reference to its names, geographic distribution, abundance, size, whether artificially propagated, market value and value as a game fish.

## **STRIPED BASS** (ROCCUS LINEATUS.)

### **ALSO CALLED ROCK-FISH.**

**Atlantic coast—Maine to Florida, ascending rivers.**

**INTRODUCED AND ABUNDANT IN CALIFORNIA.**

**Reaches a weight of about 100 pounds.**

**SPECIMENS RAISED IN THE AQUARIUM,—NOW NINE YEARS OLD.**

**An important market fish—4½ million pounds sold yearly.**

**AFFORDS TO SPORTSMEN THE FINEST OF SEA FISHING.**

#### TRANSPARENT LABEL.

*Uniforms.*—Attractive uniforms of gray cloth have been provided for the employees, which insures a neater appearance of the force in general, and is a convenience to visitors seeking information.

The Aquarium force, as a whole, has rendered satisfactory service during the year. Most of the men have been here several years.

#### ATTENDANCE.

The attendance in 1903 was 1,547,873, making a daily average of 4,240 visitors. The average daily attendance during July, August and September was 6,255. The Sunday average for the same period was 10,166. The attendance on Labor Day was 18,800. But for the extensive construction work going on in November and December, the remarkably large attendance at this institution would doubtless have been still greater. Few records of the attendance at other public institutions are available for comparison, but the New York Aquarium is doubtless in the lead in this respect. The total number of persons who visited the Metropolitan Museum of Art during the year 1903 was 802,900.

The following table shows the attendance at the Aquarium by months.

January . . . .	Total number visitors	74,255	Daily average	2,395
February . . .	" " "	81,627	" "	2,915
March . . . . .	" " "	114,391	" "	3,690
April . . . . .	" " "	135,670	" "	4,522
May . . . . .	" " "	161,538	" "	5,210
June . . . . .	" " "	133,017	" "	4,434
July . . . . .	" " "	190,939	" "	6,159
August . . . .	" " "	197,144	" "	6,360
September ..	" " "	187,382	" "	6,246
October . . . .	" " "	118,146	" "	3,811
November ..	" " "	96,233	" "	3,201
December ..	" " "	57,531	" "	1,856
Total . . . . .		1,547,873	Daily average	4,240

## BIOLOGICAL INVESTIGATION.

The Aquarium undoubtedly offers opportunities for certain kinds of biological work. With a great variety and abundance of marine and fresh-water forms of life constantly coming to the building, it would be quite possible to make the Aquarium more or less a station for biological research, as is done at some of the aquariums of Europe.

Although public aquariums and fish cultural establishments suffer more or less loss on account of the diseases of fishes in captivity, this important subject has never been thoroughly studied. It is highly desirable that some studies of this nature be undertaken at the New York Aquarium with a view to reducing the death-rate from fish-fungus and other diseases.

During the past summer the New York Department of Health conducted at the Aquarium a series of experiments relative to the possibility of infecting oysters with typhoid bacilli. Laboratory facilities were furnished in the building, and specimens and jars were set aside for the purpose.

The subject is one of great interest in connection with public health, and is of vital importance to the oyster industry.

The result of these experiments will be found in a paper in this report prepared by Dr. Cyrus W. Field, of the City Health Department.

The development of the institution to some extent along educational and scientific lines would in no way interfere with its important uses as a place of recreation for the people or appreciably increase its cost of maintenance.

Respectfully submitted,

CHARLES H. TOWNSEND,

*Director of the Aquarium.*





PHOTOGRAPH BY A. LOEFFLER.

VIEW OF THE AQUARIUM AND NEW YORK BAY.

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## NOTES ON THE MANATEE OR SEA-COW.

By CHARLES H. TOWNSEND,

DIRECTOR OF THE AQUARIUM.

THE manatee which was received on September 3, 1903, lived exactly five months, and was of constant interest to visitors. It was captured in the Sebastian River, a tributary of the Indian River, Florida, about three miles from its mouth. The animal was taken by means of a specially constructed net set across the stream, and about eight days were consumed in the hunt before it was captured. Manatees, when caught in Florida, usually strike about midway on the nets set for them, and are taken when going down stream. The net is set slack, and the shore ends of the line being cast off promptly, the animal is readily enmeshed and dragged ashore. The net employed in this instance was 150 yards long and 30 feet wide; the material being quarter-inch soft manila with 14-inch mesh.

The manatee is found throughout the Indian River and the lagoons of the eastern coast of Florida. The northern limit of its range is supposed to be the Halifax River at Ormond. It is found in the everglades, and is not uncommon about Lake Worth. Through the efforts of the Hon. F. S. Morse, of Miami, the manatee has been protected for some years in Florida and is now said to be holding its own. The species had been reported for some years as being on the decrease.

This species (*Manatus latirostris*) is supposed to be limited to Florida, although the species found in Cuba and Porto Rico, San Domingo, and other parts of the West Indies and the coast of Central America and Mexico, may be the same.

Other species are *Manatus australis*, of the northern coast of South America; *Manatus inunguis*, of the Orinoco and Amazon rivers, ascending the latter river to the borders of Peru.

*Manatus kollikeri* has been described from Surinam, and, on the other side of the Atlantic *Manatus senegalensis* is found on the west coast of Africa. Other sirenians, which should be mentioned

in this connection, are *Halicore dugong* of the Indian Ocean and *Halicore australis* of the northern and eastern shores of Australia. A species which became extinct during the past century was Steller's sea-cow (*Rhytina stellerii*), of the Commander Islands, Kamtschatka.

The Aquarium specimen was the only one in captivity in this country at the time. The Zoological Society of London has a small specimen from the Amazon.

In Florida *Manatus latirostris* is found in both fresh and salt water, as is the habit with this genus elsewhere.

The manatee is an animal which has not usually lived long in captivity. The specimen at the Aquarium was placed in a tile-lined pool 20 feet long and 13 feet wide, having a depth of 3 feet of water; the water was kept at a temperature of about 70 degrees, and renewed daily, salt and fresh water being pumped in on alternate days. This manatee could not be induced to eat lettuce, cabbage, and other vegetables usually given to such animals in captivity, but fed eagerly on eel-grass (*Zostera marina*) and pond-weed, which were supplied constantly. It became quite tame and raised its head and neck completely out of water in taking food from the hands of Mr. Washington DeNyse, who devoted much care to it. It was more or less active in the morning until feeding-time; after eating a peck or more of eel-grass, it slept on the bottom, rising to breathe at intervals of 5 to 8 minutes. Although the tank was provided with a sloping bottom at one end, the animal showed no inclination to come out of the water. When the water was drawn entirely out of the pool the manatee did not seem to take advantage of the condition to breathe with any greater frequency. The specimen was a male,  $7\frac{1}{2}$  feet long. The manatee reaches a length of at least 13 feet. It was shipped in a narrow tank containing nearly enough water to float it, an important consideration in the case of sirenians, which have bones of exceptional weight.

As a matter of interest to those not acquainted with its characteristics it may be stated that it is a warm-blooded, air-breathing, plant-eating, milk-giving, water animal. It has bones of the greatest density known among mammals, no front teeth, no hind limbs, no hip bones, and a huge beaver-like tail. It has six bones in the neck, whereas all other mammals, excepting the sloth, but including the giraffe and man, have seven.

Another interesting feature is the *position* of the milk glands, which are two in number and are placed on the breast.

A recent visitor to the Aquarium, Mr. Beverly J. Harris, who is



MANATEE.

Showing the shape of the flippers and the position in which they were usually held



MANATEE.

Head, showing about the position assumed when raised out of water to take food.



familiar with the habits of the manatee in Nicaragua, says that the species is quite common in the lagoons and streams in the neighborhood of Bluefields, and that they are often seen as far as 75 or 80 miles inland in the larger streams, where they go to feed on the so-called "manatee grass." In some streams they ascend above the rapids, and appear to bring forth their young, one or two in number, in the deeper pools above the rapids.

They are frequently speared by the Indians of Central America, who use their flesh, oil and skins to some extent.

They feed mostly at night, and according to Mr. Harris sometimes come partly out of the water to eat the water grasses along-shore.

When surprised in shallow water they exhibit great activity, getting out of the way quickly, in fact are more active under such circumstances than the appearance of the animal would indicate. Mr. Harris thinks that in Nicaragua at least they are more numerous in fresh than in salt water.

MEASUREMENTS OF MALE MANATEE AT THE NEW YORK  
AQUARIUM.

Received, September 3, 1903. Died, February 4, 1904.

Weight .....	432 lbs.
Length—Extreme .....	7 ft. 6 in.
Snout to eye .....	7
Snout to front base of flipper.....	6½
Of flipper, inside measure.....	10
Base of flipper to tip of tail .....	2 8
Base of flipper to genital opening.....	1 9
Tip of lower jaw to genital opening.....	3 3
Girth—Head at eyes .....	1 11
Neck .....	2 4½
Shoulders, back of flippers.....	4 5½
Base of tail .....	2 9
Carpus .....	1 ..
Width across front of upper lip.....	6½
“ “ widest part of tail.....	1 11
“ “ widest part of flipper.....	6

A post-mortem examination showed the cause of death to be bronchial pneumonia. The specimen was well nourished and otherwise in good condition.



GREAT HORNED OWL.

## List of Gifts TO THE ZOOLOGICAL SOCIETY.

*(Complete from January 1, 1903, to January 1, 1904.)*

- ALDEN, JOHN V., Woodmere, L. I.:  
Red Coati Mundi; Agouti.
- ANDERSON, MISS EMMA, New York City:  
English Linnet.
- ATKINS, MRS. M. J., New York City:  
Coral Snake.
- ATKINSON, GUY, New York City:  
Horned Toad (8 specimens).
- AUCHINCLOSS, MRS. HUGH D., Newport, R. I.:  
Snow Leopard.
- BAKER, D. B., New York City:  
Horned Toad (4 specimens).
- BAKER, GEORGE F., New York City:  
Eland, White-Tailed Gnu (1 pair), White-Bearded Gnu (1 pair).
- BALFOUR, F. R. S., San Francisco, Cal.:  
Lynx.
- BANKS, DAVID, New York City:  
Green Snake, Large Garter Snake.
- BARBOUR, THOMAS, New York City:  
Cobra-de-Capello (2 specimens), Bald Eagle.

- BARTELS, WILLIAM, New York City:  
Brown Gannet.
- BEEBE, C. WILLIAM, New York City:  
Green Heron (25 young specimens), Common Tern (2 young specimens, 2 half-grown specimens, 1 adult specimen), Least Tern (4 specimens), Herring Gull (adult), Laughing Gull (50 specimens), Black Skimmer.
- BELL, MISS MAE A., New York City:  
Red Fox.
- BENJAMIN, WILLIAM M., Garrison-on-Hudson, N. Y.:  
Horned Toad.
- BISCHOF, DR. ALBERT, New York City:  
Green Monkey.
- BISHOP, HENRY, Baltimore, Md.:  
1,000 Silver Fish, 5,100 Goldfish.
- BLACK, MISS FLORENCE, Brooklyn, N. Y.:  
Tovi Parrakeet.
- BOOTH, WILLIAM, West Farms, N. Y.:  
Large Garter Snake.
- BOTTHOF, MISS ROSE, New York City:  
Golden-Crowned Parrakeet.
- BREMER, I. (Medford Fancy Goods Company), New York City:  
2 Dog-Collars, studded with imitation jewels, for the two Fox Terriers at the Bird House in the Zoological Park.
- BREWSTER, ROBERT S., New York City:  
Guanaco, Alpaca, Vicunas and Llamas (1 pair each).
- BROOKLYN INSTITUTE OF ARTS AND SCIENCES (*through Dr. R. Ellsworth Call, Curator of the Children's Museum*), Brooklyn, N. Y.:  
Copperhead (2 specimens), Marine Toad (6 specimens).
- BROWN, HERBERT, Yuma, Ariz.:  
Mexican Screech-Owl (5 specimens—adult female and young).
- BROWN, OSCAR T., New York City:  
Hog-Nosed Snake.
- BRUPBACHER, G., New York City:  
Barred Dove (2 specimens).
- BURKE, DR. J. A., New York City:  
Green Monkey.
- BUTTOCK, F. STUART, New York City:  
Broad-Winged Hawk.
- CAMERON, MISS, New York City:  
Great Horned Owl.
- CASS, DR. J. L., Cameron, Texas:  
Texas Rattlesnake.
- CHAPIN, MRS. GILBERT G., New Brighton, S. I.:  
Green-Checked Amazon Parrot.
- CLEVERLEY, FRANK, Bayonne, N. J.:  
Musk-Rat.
- CLUTTERBUCK, E. H., Yonkers, N. Y.:  
Ring-Dove.
- COLL, LEON J., Woods Hole, Mass.:  
Marine Toad (27 specimens).
- COTTRELL, ORSAMUS S., JR., Keyport, N. J.:  
Red-Shouldered Hawk.
- COWLES, DAVID S., Rye, N. Y.:  
Black Bear Cub.
- COX, MRS. FULLARTON, New York City:  
Dancing Mice (4 specimens).
- DARBOES, FR. THOMAS, New York City:  
Hawksbill Turtle.

- DARBOIS, E. O., West Hoboken, N. J.:  
Alligator, Land Turtle, Spotted Turtle.
- DAVENPORT, HOMER B., East Orange, N. J.:  
English Pheasant (male).
- DAVISON, ALVIN, Easton, Pa.:  
Copperhead Snake.
- DELUCA, A., Van Nest, New York City:  
Snapping Turtle.
- DENIS, MARTIN, New York City:  
Alligator (young specimen), Musk Turtle (2 specimens—one very young).
- DIENST, A. P., New York City:  
White-Tailed Deer.
- DOOLEY, J. J., New York City:  
Bald Eagle.
- DOSSERT, JOHN, New York City:  
Sparrow Hawk (young specimen).
- DOVE, ADAM, New York City:  
The following specimens were collected by Mr. Dove and Mr. Pear-sall at Forestine, Sullivan County, N. Y.: Black Snake (8 specimens), Hog-Nosed Snake (4 specimens), Water Snake (12 specimens), Milk Snake (5 specimens), Garter Snake (57 specimens), Ribbon Snake (5 specimens), Green Snake (15 specimens), Storer's Snake (24 specimens), Ring-Necked Snake (8 specimens), Banded Rattlesnake (7 specimens).
- ECKES, HENRY, New York City:  
Sparrow Hawk (young specimen).
- EGGELING, OTTO, New York City:  
Water Moccasin.
- EINBECK, A. C., Weehawken, N. J.:  
Black-Headed Caique (2 specimens).
- ESTES, E. W., Jersey City, N. J.:  
Monkey-Faced Owl.
- FALKENSTEIN, SAMUEL, East New York:  
Alligator (young specimen).
- FAULHABER, JULIUS, New York City:  
Raccoons (2 specimens).
- FELLNER, RUDOLPH, New York City:  
Herring Gull.
- FLEET, S. J., New York City:  
Eagle.
- FORBES, JAMES C., Van Nest, New York City:  
Milk Snake.
- GALLAND, SEYMOUR N. H., New York City:  
Ring Dove (2 specimens).
- GERDING, CHARLES, JR., Croton Lake, N. Y.:  
Fox Squirrels (4 specimens).
- GILBERT, MISS, New York City:  
Raccoon.
- GILSEY, MRS. JOHN, New York City.  
Marmoset.
- GRAHAM, MASTER EDWIN SAFFEN, New York City:  
Red Squirrel.
- GWYER, K. V., University Heights, N. Y.:  
Spotted Salamanders (3 specimens).
- HAASE, CAPT. HANS, New York City (S. S. *Alleghany*):  
Three-Toed Sloth, Hawksbill Turtle.
- HADLEY, DR. F. H., Passaic, N. J.:  
Iguana.



- HATCH, EDWARD, JR., New York City:  
Raccoons (2 specimens—young).
- HEMMELSKAMP, A. D., Williamsbridge, N. Y.:  
Coot.
- HERANNEY, MRS., New York City:  
Black-and-White Capuchin Monkey.
- HIGGINS, CAPT., Bark *Nannie Swan*, South Brooklyn, N. Y.:  
Hooded Sapajou.
- HINKLEY, W. C., Stoney Creek, Conn.:  
Barred Owl.
- HOFFMANN, DR. JULIUS, New York City:  
Water Snake.
- HOGGIN, MRS., New York City:  
Green Monkey.
- HUBBARD, ASHBEEL, Mobile, Ala.:  
Red Lynx.
- HUCK, WILLIAM, New York City:  
Screech-Owl.
- HUTTER, JOHN, New York City:  
Flicker.
- ITNER, JOHN J., New York City:  
Mandrill (2 male specimens).
- JOHNSON, MRS. L. S., New York City:  
Japanese Robin.
- KAHLE, HERMAN, New York City:  
Red Newt (41 specimens).
- KAHN, HERMAN, New York City:  
Alligator (young specimen), Mud Turtle, Spotted Turtles (2 specimens).
- KATZ, WILLIAM, Bedford Park, New York City:  
English Starling (2 specimens).
- KENNY, MR., New York City:  
Sparrow Hawk (young specimen).
- KOECHLING, ADOLPH, New York City:  
Boa, Rat-Tailed Opossum (female, with young).
- KOLB, GUSTAV, Mt. Vernon, N. Y.:  
White-Fronted Amazon Parrot.
- KUBLER, GUSTAV A., Westchester, N. Y.:  
Snapping Turtle.
- LADD, CHARLES E., Springfield, Mass.:  
Gray Fox (2 specimens).
- LAMBSON, G. H., Baird, Shasta County, Cal.:  
Red-Bellied Salamander (4 specimens).
- LANGERMAN, HON. JAMES W. S., Washington, D. C.:  
Banded Rattlesnake (11 specimens—9 adult, 2 young).
- LIFE-SAVING STATION No. 12, Chadwicks, N. J. (Officers of the):  
Hog-Nosed Snake.
- LORING, J. ALDEN, Owego, N. Y.:  
Ring-Billed Gull, Painted Turtle.
- LUTZ, GILBERT C., New York City:  
German Squirrel.
- LYON, MISS LUTY, Rowayton, Conn.:  
Ring-Tailed Monkey (female).
- MCCARTHY, GEORGE M., Jersey City, N. J.:  
Broad-Winged Hawk.
- MALAHM, MRS. J. E., New York City:  
Canary (2 specimens).
- MEADER, L. J., New York City:  
Edible Snails (12 specimens).

- MEEKER, DAYTON, New York City:  
Snapping Turtle.
- MENDELSON, MRS. G., New York City:  
Ring Dove.
- MEYENBERG, E., Pecos City, Texas:  
Road Rat, Mice (3 specimens), Rat, Western Meadow-Lark (2 specimens).
- MILLER, EDWARD B., New York City:  
Gray Screech-Owl.
- MILLER, MISS JENNIE MAY, New York City:  
Screech-Owl (young specimen).
- MILLER, SIDNEY R., Newark, N. J.:  
Double Yellow-Headed Parrot.
- NEW YORK AQUARIUM (*through Mr. Charles H. Townsend, Director*),  
New York City:  
Yellow Perch (20,000 specimens).
- NICHOLSON, A. M., Orlando, Fla.:  
White Ibis (young specimen).
- NUTTING, MR., New York City:  
Sparrow Hawk (young specimen).
- OTTON, NOAH, Brooklyn, New York City:  
English Song Thrush.
- PARK DEPARTMENT OF THE BOROUGH OF THE BRONX, *through Hon. John E. Eustis, Commissioner*:  
Fallow Deer (25 specimens).
- PEARSALL, MORRIS, New York City:  
The following specimens were collected by Mr. Pearsall and Mr. Dove at Forestine, Sullivan County, N. Y.: Black Snake (8 specimens), Hog-Nosed Snake (4 specimens), Water Snake (12 specimens), Milk Snake (5 specimens), Garter Snake (57 specimens), Ribbon Snake (5 specimens), Green Snake (15 specimens), Storer's Snake (24 specimens), Ring-Necked Snake (8 specimens), Banded Rattlesnake (7 specimens).
- PIERMAN, MRS. F. E., New York City:  
Levaillant's Amazon Parrot.
- POPE, DR. G. W., New York City:  
Opossum and 12 young.
- QUAINTANCE, W. GRAY, Englewood, N. J.:  
Alligator (young).
- RHEINHARDT, EMIL, New York City:  
Western Great Horned Owl.
- RICE, MRS. T. G., Brooklyn, N. Y.:  
Pig-Tailed Monkey.
- RICHARDSON, MRS. E. S., Mamaroneck, N. Y.:  
Belgian Hares (2 specimens).
- RICHTER, WILLIAM J., New York City:  
Sea Gull (2 specimens).
- ROBOTHAM, WILLIAM, Belmar, N. J.:  
Gannet.
- ROCKEFELLER, WILLIAM, New York City:  
Russian Fallow Deer (6 specimens).
- RUHL, DR. HENRY C., New York City:  
Gray Squirrel, White-Faced Sapajou, White-Throated Sapajou.
- RUINELLO, HENRY, Hoboken, N. J.:  
Chinese Geese (1 pair).
- SCHIEFFELIN, EUGENE, New York City:  
3 Starling Coops.

- SCHILLING, ROBERT, New York City:  
 Coral Snake (5 specimens), Chicken Snake (3 specimens), Green Snake (2 specimens), Ground Rattlesnake (2 specimens), Box Tortoise (8 specimens), Water Moccasin.
- SCHROEDER, EDWARD, Jersey City, N. J.:  
 Peacock (2 specimens), Peahen.
- SCOTT, MRS. JAMES, New York City:  
 Albino Peruvian Cavy (Angora).
- SEBILLE, GUSTAVE, New York City:  
 Large-Billed Tyrant Flycatchers (2 specimens).
- SETON, ERNEST THOMPSON, New York City:  
 Turtle (7 specimens), Barn Owl (2 specimens).
- SHAW, MASTER BRIAN, Alberene, Va.:  
 Green Snake.
- SHAW, R. E., Alberene, Va.:  
 Yellow King Snake, Copperhead Snake, Hog-Nosed Snake.
- SHELDON, CHARLES, Nashville, Tenn.:  
 Grizzly Bear (young specimen).
- SILVERNAUL, S. J., New York City:  
 Raccoon.
- SPAETH, REYNOLD A., Philadelphia, Pa.:  
 Sparrow Hawk (5 specimens).
- SPINNING, E. S., Jersey City, N. J.:  
 Golden Eagle.
- STEIN, EDWARD, Yonkers, N. Y.:  
 Alligator (young specimen).
- STEWART, MRS., New York City:  
 Indigo Bunting.
- STREETER, D. D., JR., Brooklyn, New York City:  
 Red-Tailed Hawk, Purple Finch, Mud Puppy, Black-Crowned Night Heron.
- TACOMA, WASHINGTON (CITY OF) (*through Board of Park Commissioners, Mr. Stuart Rice, President*):  
 Olympian Elk (2 specimens).
- THOMPSON, A., New York City:  
 Chipmunk (6 specimens).
- THOMPSON, C. D., Bernardsville, N. J.:  
 Golden Eagle.
- THOMPSON, MRS., New York City:  
 Large Albino Rabbit.
- THOMPSON, MRS. FREDERIC FERRIS, New York City:  
 African Ostrich (1 pair), Baker's Roan Antelope, Addax Antelope, Beatrix Antelope, Sing-Sing Waterbuck, Altai Wapiti (1 pair).
- TILLEY, G. D., Darien, Conn.:  
 Gadwall Duck.
- TITUS, MRS. F. C., New York City:  
 Yellow-Faced Parrakeet.
- TOMANN, JOHN, New York City:  
 Yellow-Bellied Terrapin (2 specimens).
- TOMLINSON, MISS D., New York City:  
 Levaillant's Amazon Parrot.
- URBANSKI, MRS., New York City:  
 Levaillant's Amazon Parrot.
- VON BRIESEN, ARTHUR, New York City:  
 Marmoset.
- WADSWORTH, W. A., Geneseo, Livingston County, N. Y.:  
 Adult Red Fox and 2 Cubs.
- WALL, ARTHUR W., New York City:  
 Red Fox (2 young specimens).

- WALLACE, WILLIAM, JR., New York City:  
 Garter Snake (200 specimens).  
 WALLACE, WILLIAM M., Williamsbridge, N. Y.:  
 Alligator.  
 WHEALTON, LOUIS N., New York City:  
 Black Duck, Pintail Duck (2 specimens), Green-Winged Teal (2 specimens), Whistling Swan (2 specimens), Egyptian Geese (2 specimens), Common Tern (adult), Least Tern (4 specimens), Herring Gull (adult), Laughing Gull (50 specimens), Common Tern (2 half-grown specimens), Black Skimmer.  
 WHITFIELD, MRS. HENRY D., New York City:  
 Jack Rabbit (4 specimens).  
 WHITNEY, HON. WILLIAM C., New York City:  
 Buffalo (26 specimens), Elk (10 specimens).  
 WITHERBEE, W. G., Port Henry, N. Y.:  
 Whistling Swan.  
 WREN, DR. A. A., New York City:  
 Boa.

### Recreation Series.

*Gifts from the readers of Recreation Magazine, through Mr. G. O. Shields, Editor and Manager.*

- GARRETTE, P. J., Collinsville, Conn.:  
 Red-Shouldered Hawk (2 specimens).

### Gifts of Plants.

- ACKERMAN, MRS. J. E., Mt. Vernon, N. Y.:  
 Two *Cycas revoluta*.  
 ARENT, MRS. CHARLES, Yonkers, N. Y.:  
 One Myrtle-Tree.  
 CATLIN, MRS. JULIUS, Fairholme, Morristown, N. J.:  
 One *Seaforthia Palm*.  
 HOMAN, MRS. F., New York City:  
 Rubber Plant.  
 HYDE, C. M., The Chimneys, Greenwich, Conn.:  
 A large collection of Plants.  
 SHERMAN, MRS. BYRON, Morristown, N. J.:  
 A large collection of Plants.  
 TIENKIN, MRS. L. C., Rahway, N. J.:  
 2 large Rubber Trees.  
 VICKERY, FREDERICK, Mt. Vernon, N. Y.:  
 One large Rubber Tree.  
 WOOD, MRS. CLARISSA L., Katanah, Westchester County, N. Y.:  
 A large and valuable collection of Plants.

### Gifts to the Library.

- AMERICAN MUSEUM OF NATURAL HISTORY, New York City:  
 Bulletin of the American Museum of Natural History, Vol. XVI.  
 BARBOUR, THOMAS, New York City:  
 Essays Relating to Indo-China, 4 vols.

- BEEBE, C. WILLIAM, New York City:  
 Fancy Pheasants and Their Allies.  
 Quailogy.  
 94 Numbers of Science, in 5 vols.
- BRITISH MUSEUM (THE TRUSTEES OF THE), London, S. W., England:  
 Hand-List of Birds, Vol. IV.  
 Catalogue of Birds' Eggs, Vols. I., II., and III.
- BROOKLYN INSTITUTE OF ARTS AND SCIENCES, Brooklyn, New York City:  
 Cold Spring Harbor Monographs, 2 vols.
- GEOLOGICAL SURVEY OF CANADA:  
 Annual Report of the Geological Survey, etc., 1899.  
 Catalogue of Canadian Birds.
- GOELDI, PROF. DR. E. A., Para, Brazil:  
 Estudos sobre o desenvolvimento da armacao dos veados galheiros do Brazil.
- LINNEAN SOCIETY, New York City:  
 Abstract of the Proceedings of the Linnean Society.
- MORGAN, J. P., JR., New York City:  
 Zoological Record, Vols. I. to XXXVII., inclusive, Years 1864 to 1900, inclusive, including the Index Zoologicus—Zoological Record—Index Volume, 1880-1900.
- NEW YORK BOTANICAL GARDENS, Bedford Park, New York City:  
 Histoire Naturelle des Oiseaux, 5 vols.  
 Œuvres Completes de M. Le Cte. de Buffon, etc., 7 vols.  
 Practical Taxidermy. By Montagu Browne.  
 Animal Breeding. By Thomas Shaw.  
 Natural History of New York.  
 The Natural History of Norway.  
 Mexican Boundary Survey, Part II.  
 Smithsonian Report—National Museum—1889.  
 Geological Survey of New Jersey, Vol. II., Part II., 1890.  
 Pacific Railroad Survey Reports, 3 vols.  
 Eleventh Report of the New York State Entomologist.  
 Invertebrate Faune of the Yellowstone Park. By S. A. Forbes.  
 Bulletin of the Museum of Comparative Zoology, 15 Parts.  
 63 Zoological Pamphlets.
- PETTIGREW, J. A., Jamaica Plain, Mass.:  
 The Antelope and Deer of America. J. D. Caton.
- PHILADELPHIA ACADEMY OF SCIENCES, Philadelphia, Pa.:  
 Proceedings of the Academy of Natural Sciences, 4 vols.
- SCLATER, DR. P. L., Odiham Priory, Winchfield, England:  
 List of the Vertebrated Animals. Zoological Society of London, 1879.  
 Vertebrated Animals in the Zoological Society of London, 1877.  
 List of Vertebrated Animals in the Zoological Gardens, 1872.  
 Catalogue of the Library. Zoological Society of London, 1886.  
 Library of the Zoological Society.  
 Library Catalogue, Zoological Society of London, 1872.  
 Guide to the Gardens of the Zoological Society of London, 42 copies, bound in cloth.
- SMITHSONIAN INSTITUTION, Washington, D. C.:  
 Annual Report of the Smithsonian Institution, 1901.
- UNIVERSITY OF MONTANA:  
 A Biological Reconnoissance in the Vicinity of Flathead Lake. Elrod.  
 Lectures at Flathead Lake.

### Gifts to the Aquarium.

- BROWN, C. E., Highland, N. Y.:  
 Alligators (3 specimens—small).

- BEEBE BROTHERS, Sayville, L. I.:  
Winter Flounder.
- BISHOP, HENRY, Baltimore, Md.:  
Collection of fancy goldfishes, several varieties.
- BURNS, J., New York City:  
Box Tortoise.
- CALEB, HALEY & Co., New York City:  
Florida Soft-Shell Turtle.
- CARMICHAEL, WILLIAM, Staten Island, New York City:  
Young File-Fish.
- DIX, MAY ELIZABETH, Brooklyn, New York City:  
Young Alligator.
- DRYDEN, HON. JOHN F., Newark, N. J.:  
Lobster (large specimen).
- DWYER, J. F.  
Turtle.
- ELDRIDGE, R. H., & Co., New York City:  
Turtle.
- FAJEM, WILLIAM, New York City:  
Green Turtle.
- GOHLKE, JOHN W., Jersey City, N. J.:  
Blotched Salamander.
- HAASE, CAPTAIN H., S. S. *Allegheny*:  
Land Hermit Crabs (4 specimens), Hawksbill Turtle.
- HANSEN, CAPTAIN, S. S. *Fortuna*:  
Sea Turtle.
- HOUSTON, FRED., Brooklyn, N. Y.:  
File-Fish.
- HUDSON, LILLIAN, New York City:  
Small Alligator.
- KIRK, GEORGE C., Syracuse, N. Y.:  
Mud-Fish (2 specimens), Bullfrogs (2 specimens), Snapping Turtle,  
Bullhead.
- LAMBSON, G. H., Baird, Cal.:  
Salamanders (14 specimens) from California.
- LAPP, HENRY:  
Blue Crab.
- LYNCH & Co., New York City:  
Green Crabs (950 specimens).
- MYERS, G. C., Englewood, N. J.:  
5 small fishes from Georgia.
- NEW JERSEY FISH AND GAME COMMISSION:  
Pickerel, Crappie, Scale Carp, Yellow Perch, Sunfish, Catfish, Brook  
Sucker, Common Roach, Pirate Perch, Mud Minnow (44 speci-  
mens in all), and 6 miscellaneous species.
- NICHOLS, EMMA, Brooklyn, N. Y.:  
Painted Turtle.
- O'NIEL, LAMBERT, Staten Island, New York City:  
Sea Turtle (large specimen).
- PENTECOST, MRS. H. O.:  
Small Alligator.
- PRATT INSTITUTE, Brooklyn, N. Y.:  
Small Alligator.
- REDFIELD, BESSIE, Closter, N. J.:  
Bullfrogs and Salamanders.
- REDFIELD, EDWARD T., Closter, N. J.:  
Turtles (7 specimens), Bullfrogs (2 specimens), 1 Tortoise, several  
Salamanders.

- RICHARDSON, F. F., Paterson, N. J.:  
Green Turtle.
- ROBINSON, CHARLES H., Staten Island, New York City:  
Alligators (2 specimens).
- SEARING, GEORGE E., Towanda, Pa.:  
Collection of Tadpoles, Newts, and small fishes.
- SKEIL, MRS. H., New York City:  
Diamond-back Terrapin.
- SOUTH SIDE SPORTSMEN'S CLUB, Long Island:  
Collection of Trout.
- STEEB, HAROLD, Sparkill, N. Y.:  
Bullfrogs (2 specimens).
- STONE, MAX, New York City:  
Small Alligator.
- TAYLOR, G. W., Closter, N. J.:  
Bullfrogs (2 specimens), Collection of Salamanders.
- TOWNSEND, C. H., New York City:  
Turtles (46 specimens).
- TUXEDO CLUB, Tuxedo, N. Y.:  
150 specimens of fishes, representing 9 species.
- ULHORN, THEODORE, Brooklyn, N. Y.:  
Young Alligators (2 specimens).
- UNITED STATES FISHERIES BUREAU, Washington, D. C.:  
Important donation of fishes and fish eggs—acknowledged in previous report.
- VANDOREN, FRED., Hoboken, N. J.:  
Small Turtles (2 specimens—small).
- VOGEL, JOSEPH, Brooklyn, N. Y.:  
Snapping Turtle.
- WALTERS, C. H., Long Island, N. Y.:  
Brook Trout (24 specimens), Small Pickerel (32 specimens), Darters (9 specimens).
- ZUMBUSCH, WILLIAM F., Jersey City, N. J.:  
Alligator.

### Gifts to the Aquarium Library.

- AMSTERDAM AQUARIUM, from Dr. C. Kerbert, Director:  
Copy of the Feestnummer (50th anniversary vol.).  
Amsterdam Zool. Soc.
- BROOKLYN INSTITUTE:  
Cold Spring Harbor Monographs, Nos. 1 and 2.
- CALIFORNIA STATE FISH COMMISSION, from Charles A. Vogelsang, Chief Deputy:  
Reports California State Fish Commission.
- CONGDON, J. W.:  
Report on Japanese Fisheries and Aquaria.
- GREGG, WILLIAM H.:  
When, Where and How to Catch Fish on the East Coast of Florida.
- MASSACHUSETTS FISH COMMISSION, from Captain J. W. Collins, Chairman:  
Reports Massachusetts Fish Commission, 1869 to 1902.
- NEW JERSEY STATE FISH COMMISSION, from H. P. Frothingham, President:  
Reports New Jersey State Fish Commission, 1901 and 1902.
- NEW YORK STATE FOREST, FISH AND GAME COMMISSION, from John D. Whish, Secretary:  
The Food and Game Fishes of New York.  
Reports New York State Fish Commission, 1898 to 1900.
- NEW YORK STATE MUSEUM, from Frederick J. H. Merrill, Director:  
Natural History Museums of United States and Canada.

PENNSYLVANIA FISH COMMISSION, from Joseph Kalbfus, Secretary:  
Game and Fish Laws of Pennsylvania.

SHUFFELDT, DR. R. W.:  
Osteology of the Steganopodes.

SMITHSONIAN INSTITUTION:  
Current Publications.

TOWNSEND, CHARLES H.:  
Explorations of Steamer *Albatross*, 1883.

UNITED STATES FISHERIES BUREAU:  
Current Publications.

WEEKS, HENRY CLAY:  
Papers on Extermination of the Mosquito.

### Purchases.

STEAMER *Angler*—collections from the fishing banks off the New Jersey Coast:

6 Mutton Fish, 45 Dog-Fish, 20 Bergalls, 4 Sea Robins, 2 Cunner, 8 Whiting, 10 Hake, 14 Sculpin, 1 Rock-Fish, 3 Crabs, 2 Anglers, 39 Sea Ravens, 29 Skates, 11 Black-Fish, 1 Portuguese Man-of-War, 23 Puffers, 2 Pollock, 1 Conger-Eel, 1 Cod-Fish, 1 Fluke, 2 Mussels, 1 Bass, 1 Trigger-Fish, 1 lot of Barnacles.

M. C. LOHSEN—collections from New York Bay:

2 Fox-Fish, 2 Porgies, 7 Drum, 9 Sea-Horse, 5 Spotted Codlings, 35 Orange File-Fish, 17 Scup, 23 Spot, 3 Prawn, 3 Bergalls, 11 Crabs, 4 Mullet, 5 Lobsters, 1 Skate, 1 Sole, 9 Bass, 8 Black-Fish, 25 Mackerel, 18 Toad-Fish, 2 Eel, 5 Puffers, 1 Pilot-Fish, 8 Moon-Fish, 1 Herring, 1 Blue-Fish, 1 Silver Gar, 1 Jelly-Fish, 3 Sea Robins, 1 Sea Raven, 2 Catfish, 2 White Perch, 1 Hake, 1 Flounder.

TROPICAL FISHES—from Bermuda:

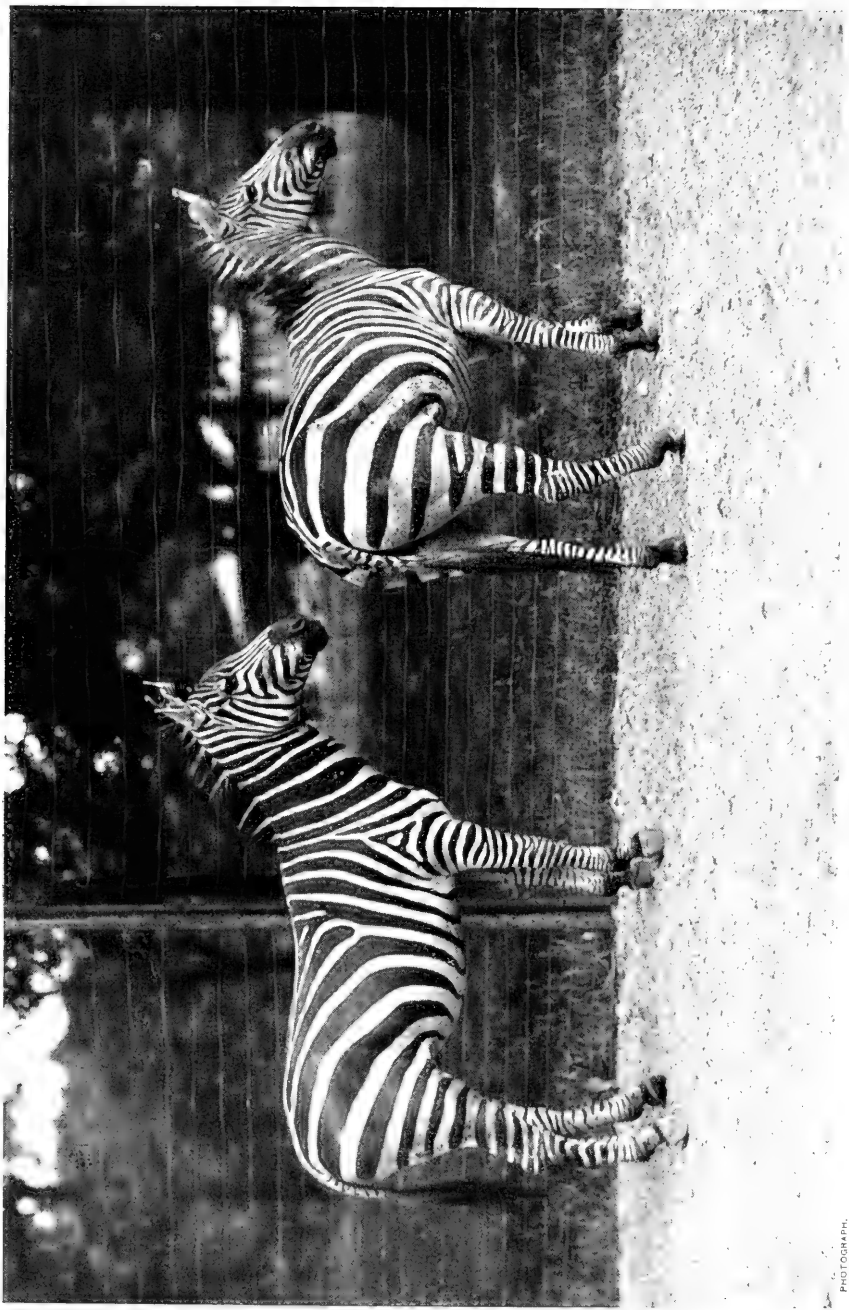
2 Mud Bellies, 2 Butter Hamlets, 6 Moray, 17 Snappers, 52 Squirrel, 1 Deer Hamlet, 8 Trigger-Fish, 5 Cow-Fish, 1 Porgy, 20 Trunk-Fish, 12 Rock-Fish, 11 Slippery Dick, 9 Bermuda Chub, 1 Crab, 14 Schoolmaster, 21 Beau Gregory, 2 Cataphœbe, 6 Hog-Fish, 3 Amber-Fish, 1 Cardinal-Fish, 11 Groupers, 62 Angel-Fish, 14 Parrot-Fish, 29 Surgeon-Fish, 9 Lady-Fish, 169 Foureyes, 4 Mollie Miller, 1 Margate-Fish, 9 Coneys, 1 Craw-Fish, 35 Yellow-Tails, 59 Grunt, 8 Bream, 4 Octopus, 31 Sergeant Major, 3 Butterfly-Fish.

OTHER PURCHASES:

1 Crocodile, 1 Manatee, 1 Harbor Seal, 11 Turtles, 16 Terrapin, 1 Thread-Fish.







ELWIN H. SANDORF

# CRAWSLAY'S ZEBRA.

The Society has a pair of fine specimens in its collections.

PHOTOGRAPH.

# ON THE POSSIBILITY OF INFECTING OYSTERS WITH TYPHOID BACILLI.

By CYRUS W. FIELD, M.D.,

ASSISTANT BACTERIOLOGIST, DEPARTMENT OF HEALTH, N. Y.

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THIS work was undertaken at the suggestion of Dr. William H. Park, Director, Research Laboratory, Health Department, to determine whether or not the oyster could be a means of infection, and, if so, under what conditions it would act in this manner. The oysters were kept at the New York Aquarium, where all facilities were granted.

## TECHNIQUE.

The oysters were placed in large glass jars containing about 8 gallons of sea water, balanced with vegetable life. The specific gravity of this water varied from 1.012-1.014, which was much lower than that of deep-sea water, but not very different in any respect from that over the oyster beds in most localities where oysters are grown for the market.

The first tank was infected by introducing a litre of a 24-hours bouillon culture of *Bacillus typhosus*, and thoroughly mixing it. At the end of 24 hours the water in the tank was discolored, and at the end of three days was very foul. The oysters were tightly closed. In this first experiment there were placed in the tank, besides the oysters, some soft-shell and little-neck clams. The little-neck clams were as tightly closed as the oysters, but the soft-shell clams had their siphons fully extended and some were evidently dead, as they did not retract them on their being touched, while others retracted them but slowly.

It was evident that the tank was now unbalanced; that is, the vegetable life in it failed to give off sufficient oxygen to support the animal life, and that the mollusks were rapidly dying.

They were removed, and three oysters and two clams were examined. In oyster No. 1 no typhoid organisms were found. This

oyster was normal in every respect, and its heart was pulsating when opened. In oyster No. 2, 25 per cent. of the organisms isolated from it were found to be *Bacillus typhosus*. On opening this oyster no signs of life could be detected. No. 3 was dead beyond doubt, and had turned black; and in this case all organisms tested were found to be *B. typhosus*.

The two little-neck clams examined looked normal in every way, except that no pulsation could be noticed in clam No. 2. No typhoid bacilli could be found in No. 1, whereas No. 2 showed all organisms to be *B. typhosus*.

It was seen from this that this method of infecting the tanks could not be used, so in all further work the tanks were infected in the following manner:

The bacilli were sown on agar planted in flasks. They were incubated for 24 hours. At the end of 24 hours about 20 c.c. of sterile sodium chloride solution was placed in the flask, and the growth washed off the agar into this solution. This was poured into the tank, and more fresh sodium chloride solution placed in the flask, to wash the remaining bacilli off, as the whole growth could not be removed at the first washing. This was also added to the tank.

After this the oysters were removed at the end of certain periods for examination. After the first experiment five oysters were removed each time. These were washed and scrubbed to remove as many organisms as possible from the shell. The oyster was then opened by cracking off the edge and inserting a sterile platinum needle and stirring it around, then draining the juice into a sterile beaker glass. One-tenth of a c.c. of this juice was used to inoculate each tube of plate media. The plates were incubated for 48 hours, and then either 20 or 40 colonies were planted in bouillon—that is, 20 or 40 colonies from each oyster of the 5 removed, making either 100 or 200 colonies examined. At the end of 24 hours the bouillon cultures were tested in the hanging drop, with the serum of a young goat immunized to *B. typhosus*, and having great agglutinative power for this organism. The dilution used was 1-800. If the organisms in the tube did not agglutinate, they were thrown out, and no further test was made on them. If they showed agglutination, they were planted in Dunham's solution, and tested for indol, also in lactos bouillon for gas production, and in milk for coagulation; but later in my work I relied wholly on the agglutination test.

It will be seen from Chart I, that when the oysters remain in the infected water the *B. typhosus* may remain present until the

Number of oysters tested.	Number of bacteria per c.c.	Duration of time in		Number of bacteria in oysters per c.c.	Percentage of bacillus typhosus in oysters.
		infected tank.	non-infected tank.		
5	20,000	24 hours.	0 hours.	1,200	22 per cent.
5	14,400	48 "	0 "	900	18 "
5	8,000	96 "	0 "	750	9 "
5	6,500	7 days.	0 "	570	7 "
5	4,200	9 "	0 "	490	1 "
5	4,600	14 "	0 "	300	0 "
5	19,500	24 "	0 "	1,300	19 "
5	"	24 "	24 "	650	5.5 "
5	"	24 "	48 "	300	3 "
5	"	24 "	96 "	240	0 "
5	"	24 "	7 days.	200	0 "
5	"	24 "	9 "	210	0 "
5	"	24 "	14 "	190	0 "
5	"	24 "	21 "	200	0 "
5	"	24 "	28 "	190	0 "

7th day, but when removed to fresh sea water they disappear before the 3d and 4th days.

This is the result of dilution and the action of the sea water. I found that in the sea water used in these experiments *B. typhosus* was destroyed in from six to eight days, 50 per cent. being destroyed in the first 24 hours.

When the oysters were removed from the infected tank, and kept either directly on ice or else in a compartment of the ice box, as under market conditions, there was a very slight diminution of the number of bacteria per c. c. and a slight increase in the per cent. of *B. typhosus* present. Thus, if oysters have been infected they may retain this infective material, and in this manner may act as disseminators of typhoid fever.

Now the question arises, Does the oyster ever come in contact with infective material? If it does, does not the fresh sea water over its beds dilute and destroy the organisms? To this I should say that if the oysters were taken from the beds situated in deep water, where the flood tide brought pure sea water to them, that there would be very slight chance of infection. But it is not from these beds that the oysters are brought to market. After they are brought up from the natural beds they are generally placed in creeks where the water is brackish, being deposited in small houses built on the edge of the stream. These houses at low tide are nearly dry; but as the tide rises they become filled with water, which finally covers the oysters, and where a hissing noise can be heard as the oysters suck it in. There being a specific gravity less than that which has covered the oysters on their native beds, there occurs, owing to osmosis, an enlargement of the oysters, making them "fat" and plump. This process is therefore called "fattening," and plumping or drinking.

The great danger in this is, that the streams used for this purpose may be contaminated by sewage. Should a case of typhoid fever occur where there is drainage into a stream, oysters may become polluted. This was just what occurred in the epidemic at Middletown, Conn., in 1894, and which was traced directly to oysters fattened on the banks of the Quinepiac River near New Haven. There had occurred a short time before a case of typhoid fever in a person living on this stream, and the discharges had been drained directly into this river. Wherever this lot of oysters had been shipped there had followed typhoid fever in those who had eaten them.

The conditions are still the same in many places where oysters are shipped to market. In one stream I took samples of the water

around the oyster drink-houses, and in every sample isolated *B. coli communis*. Where this organism is found in water it is held to be indicative of contamination by human excreta.

In conclusion, it would seem as though the only way to protect the public would be to forbid the sale of fattened oysters and to enforce it; also to see that oyster beds were not subject to contamination from streams used for sewage purposes. The most important measure would be the prevention of the process of oyster "fattening" where the water was or could be contaminated.

For lack of space, the studies of Foote in the Report of the State Board of Health of Connecticut, 1895; Klein of London in Local Government Board Reports, 1894-95; and of Prof. Herdman of the Liverpool Biological Laboratory, are not discussed in this connection.

# ANNUAL REPORT OF THE MEDICAL DEPARTMENT OF THE ZOOLOGICAL PARK FOR 1903.

DR. HARLOW BROOKS, PATHOLOGIST,

DR. W. REID BLAIR, VETERINARIAN,

TO THE BOARD OF MANAGERS.

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THE following report of the Medical Department of the New York Zoological Park relates only to the pathological side of the subject. The clinical treatment of the animals will be dealt with at length in our next report.

During the year 1903 autopsical investigations have been made on every animal which has died in the Park, and our records concerning the same are complete.

The work in this department has been more thoroughly done than was possible during the two preceding years, since we were able to start in with a well-organized staff, and with a clearly defined idea as to the lines along which our efforts should be best directed.

From our previous work we have found that the most serious mortality of the animals under our charge has been among the mammals, and, at the same time this class of animals comprises the most expensive and important of the collection at the Park. Chiefly for these reasons, and because with our limited staff it has been impossible to give the requisite amount of attention to the deaths in the Reptile and Bird collections, it has seemed best to devote our attention, for the past year, entirely to the mammals, hence the subject material of this report deals only with the conditions found in this class.

Although the examinations have been thoroughly and systematically made during the past year, they have been conducted so as not to damage the material for the use of the taxidermist. Indeed, we find that a mutual understanding between pathologist and taxidermist makes the specimens equally valuable to both without, except in rare instances, loss to either.



During 1902, 227 deaths are recorded; most of these cases came to autopsy. During the past year the collection has been considerably enlarged in the number of valuable species, yet the deaths which have occurred during 1903 have been only 113; a noticeable decrease in the mortality. We shall show further on in our report that this decided diminution in the death rate has been mostly in those diseases which may be characterized as *preventable*, and it is certain that the great improvement has been due not to fortune nor to the fact that less delicate species of animals have been kept this year, but chiefly, if not entirely, to the quarantine system, the treatment of sick animals, and perhaps most of all to the preventive measures which previous experience has taught us to put into practice at the Park.

Of the stock present during the past year, 503 were carried over from 1902, and during 1903 accessions were added as follows: hoofed stock 123, primates 47, miscellaneous mammals 60. Total 733. Our death-rate, therefore, gives a mortality of about 15.4 per cent., apparently large, but when we consider the previous rate, it is seen to be small, especially when we remember the normally short life of most wild animals.

In so far as I have been able to learn from other reports, and from personal observation, I do not think that we should expect to markedly reduce the percentage below that reached this year if the Society still continues to keep the same high-class stock which they now carry. It is also to be expected, that from time to time infected animals will creep into the collection, despite the most cautious supervision, and we must therefore reckon on occasional outbreaks of infectious and contagious diseases from which we have been very free for the past year. We must see to it that no laxity or carelessness on our part is responsible at any time.

It is very significant that of our 113 deaths, 21 took place in animals but very recently introduced to the Park. Seventeen of these arrived in a moribund condition, a large proportion of them were never placed on exhibition, and all 21 died within a few days of conditions contracted before their arrival at the Park. Among these animals were several expensive additions made to the collection.

Equally important in this relation is the always imminent danger that animals may contract diseases of a contagious nature which may not become evident until the stock has become the property of the Society.

## INJURIES.

The Society should congratulate itself on the fact that but nine deaths have been due to accident. This number, of course, includes all animals which were killed on account of injuries received by accident. It also speaks very highly for the general efficiency of the keepers, since but one of these accidents occurred as the result of gross carelessness or thoughtlessness; the other eight cases being mostly the result of the inevitable quarrel between animals, or of other causes which may be justly classified as *unavoidable*.

## MONTHLY DEATH RATE.

Careful observations have been made in order that it might be determined whether the month or time of year had anything to do with the death rate, as is the case with human disease in this climate. Our statistics are as yet too few to allow any well-founded speculations in regard to this matter, though in the course of a few years we may find the facts which we are now collecting of some considerable value. Taken singly, this year's figures seem to indicate that the monthly death-rate is more dependent upon the monthly accessions than on any other factor. The figures are as follows:

January..... 5	April..... 10	July..... 9	October..... 7
February.... 8	May..... 6	August..... 12	November... 11
March..... 14	June..... 8	September... 12	December... 11

## DIETETIC DEATH RATE.

Observations are being made in relation to the number of deaths which occur among the various types of animals classified in regard to their food. Thus during the past year 1 Carnivore, 32 Ungulates and 34 Primates have died. Improvement is especially evident among the Primates, where the deaths have been reduced from 89 instances in 1902, to but 34 in 1903.

## PROPHYLACTIC MEDICINE.

This department has especially concerned itself during the past two years in the adaptation to the Park of the principles of *preventive medicine*, and during this last year we have particularly

devoted ourselves to the consideration, from this standpoint, of the *contagious diseases*. Chief among these is *tuberculosis*, and in the last year's report I dealt rather extensively with this matter, recommending that a most rigid quarantine and isolation system be put in force with special regard to tubercular animals. Dr. Blair has shown us, as stated in last year's report, the manner by which this disease is transmitted, and we have put our observations to practical test with the gratifying result that but 9 deaths from this disease have occurred this year, and 4 of these cases entered the Park in a hopelessly infected condition. So at the outside but 5 cases can have developed in our compounds during the past year; this as against 39 deaths from tuberculosis among the Primates alone last year. Further observations but confirm our ideas as regards the infection, course and lesions of the disease, as expressed in last year's report. Our successful methods of dealing with this contagion may be expressed briefly as follows: Rigid quarantine of all infected or suspected animals; isolation as soon as the disease develops, special diet, hygiene, and proper medication with thorough disinfection of the quarters of infected stock before healthy animals are placed in the same cages.

With the other chief contagious diseases similar methods have given us very like results, and for the sake of comparison we have grouped them with my last year's incomplete records.

	1902.	1903.
Actinomycosis .....	5	0

(It is important to note here that one case of *actinomycosis* was sent to the Park, but in the routine of the quarantine of incoming animals the case was detected by Dr. Blair and at once isolated, thus doubtless preventing a repetition of the calamity of last year. It is also interesting to note that Dr. Blair is apparently achieving some result in the treatment of this animal, though it is very doubtful if it will be safe to place it with healthy stock; still, it is of great interest to stock raisers as well as to animal men, if some reliable treatment for this very refractory and serious disease can be discovered.)

	1902.	1903.
Distemper .....	10	0
Anthrax .....	0	0
Rabies .....	1	0
Unclassified .....	0	0

## INFECTIOUS DISEASES.

*Not Strictly Contagious.*

*Pneumonia*.—Ten deaths have occurred from this disease during the past year as compared with 33 cases last year. Three of these cases have followed infection with bronchial filaria. In other instances the prevailing factors seem to have been those discussed in last year's report under the heading of "Pathological Effects of Captivity on Wild Animals." Deaths from pneumonia in these cases are so frequent that it really seems as if it may be necessary to attempt to devise some method by means of which the animals may be forced to take more exercise, a matter which Mr. Hornaday has discussed several times with me, and which I find has been noted by Bostock in his recent book on the training of wild animals.

*Post-Partum Sepsis*.—There is a widely prevalent idea in the public mind, and to a certain extent among medical men, that post-partum sepsis is almost unknown except in the human, and that it is rare among the uncivilized peoples, the latter being used not infrequently as an argument for the so-called "Nature Life" as opposed to the methods of modern asepsis and antisepsis. It is, therefore, most interesting to note that during the past year two fatal cases of post-partum sepsis have occurred, one in an East African baboon and one in an Indian leopard, notwithstanding the fact that the cat family are usually resistant to the ordinary infections. In these two animals the disease appears to have followed the general course usually present in the human, infection having taken place through the vagina and extending up through the uterus and into the tubes, setting up peritonitis by extension, with finally a general sepsis. No bacteriological studies were made on the cases, but both were apparently induced by dystocia, and it seems necessary that more care be exercised in the selection of animals for propagation, and that special methods for their feeding and exercise be devised. This is already under consideration.

## NON-INFECTIOUS DISEASES.

*Gastro-Enteritis*.—Deaths from gastro-enteritis have not been so frequent during the past year as they were formerly, but 12 cases dying from this disorder as compared with 43 cases last year. Seven of these deaths were among the mountain sheep, and,

as in our previous experience with this disease, the undoubted cause was the cropping of the grass which grows in the enclosures. From our observations there can be no doubt but that the proposition made in an earlier report must be complied with before we are reasonably free from it; that is, that the entire food and water supply of all the animals, particularly of the native Herbivora, must be placed immediately under the control of the keepers. It is worse than useless, after our experience, to attempt to furnish a natural food supply within the ranges. The complete absence of fatal gastro-enteritis among the Primates, whose food and water supply has been very carefully supervised during the past year, entirely demonstrates the benefits guaranteed by these methods.

#### PARASITIC DISEASES.

Deaths from parasitic diseases have been much reduced during the past year, only 7 fatalities arising from this cause. This favorable result, in the case of intestinal parasites, in my opinion is mostly due to the fact that, under the direction of your Veterinarian, vermifuges have been systematically employed, and oftentimes the result has been the voiding of large numbers of parasites, fortunately before the animal had been directly killed by the parasites, or before they had set up a serious gastritis or enteritis. This one fact alone places far beyond question any doubt as to the value of medicinal treatment of wild animals in captivity, for animal men tell us that intestinal parasites are among the most serious factors with which they have to deal, and certainly our experience before these methods were introduced bears out this idea. One badger died as the result of intestinal nematodes, but no fatal cases of *tænia* infection have occurred during the past season.

*Cysticerci*.—There has been a marked diminution in the number of cases exhibiting cysticerci and hydatid cysts. During the past year but two cases were found, while, as I mentioned in a previous report, at one time these cysts were present in nearly every case dying in the Park. Doubtless this year's records in regard to this have been partly a matter of good fortune, but it is also certain that the general methods of cleanliness, now so universally enforced about the animal enclosures, has reduced the number of infections occurring in the Park itself. The careful supervision of the food is also doubtless a factor; however, I do not believe that it will ever be possible to eradicate the disease entirely, since

we must secure our stock from dealers in whose enclosures infectious and questionable food are the rule rather than the exception. We can, therefore, only hope to exclude the more serious cases by our quarantine system and to prevent, in so far as possible, infections within the Park. Later on it may be practical to make microscopic examinations of the ejecta of all new animals which enter the collection, and by this means we should be able to exclude still more cases and thus greatly reduce the possibility of intra-park infections.

*Mischerschen Schleuche*.—As predicted in my previous report the *Mischerschen schleuche* has been found in the myocardium of all the elk which have died or which have been killed. Bronchial filaria have also been universally present in these animals.

*Bronchial Filaria*.—From incomplete experiments made by me, I am about convinced that bronchial filaria are at least sometimes communicated directly from animal to animal by means of the ovæ or embryos of the parasite which, I believe, I have shown may sometimes develop directly into the mature filaria without the intervention of an intermediary host, though this is probably generally present. There can be no doubt but that the infective agent, probably the ovæ or embryos, are conveyed through infected dirt or water, but so far we have been unable to confirm our ideas experimentally.

For the purpose of statistical information it has seemed best to me to classify certain diseases as they occur at the Park under the heads of the systems, for though this method is subject to many disadvantages, after a few years such records will doubtless be of considerable statistical value.

#### DISEASES OF THE CENTRAL NERVOUS SYSTEM.

Five animals have died from diseases of the central nervous system, two from cerebral hæmorrhage, one of traumatic origin, one case from cerëbro-spinal meningitis, one from acute cerebral meningitis with acute mania (a cheetah) and two from "cage paralysis." Since these instances are to be discussed in a special communication, it seems unnecessary to more than mention them here and to call attention to the appreciable large number of deaths from this class of disease, consequently the importance of prophylaxis and of a more thorough study of these conditions, not only on account of their great value to comparative medicine and pure science, but also for the more purely economic problems of a great zoological collection.

## CARDIO-VESICULAR SYSTEM.

*Myocarditis* is doubtless the most important disease of this system arising among our animals; the general conditions inducing it were discussed in last year's reports under "Effects of Captivity on Wild Animals." Needless to say this serious condition has been present in all of the elk of the old herd which have come to autopsy. One mule deer died from a fibrinous pericarditis.

## RESPIRATORY SYSTEM.

The only cases that come under this heading have already been discussed under tuberculosis, pneumonia, and as concerning the bronchial filaria.

## DIGESTIVE SYSTEM.

The important diseases of this tract have already been considered under gastro-enteritis and, in a previous communication, under *fatty degeneration of the liver*. Three fatal cases of fish poisoning occurred among the sea lions; one of this same group of cases recovered.

## SPLEEN AND LYMPHATIC SYSTEM.

Only secondary lesions have been found in these organs, mostly tuberculosis and simple hyperplastic lymph-adenitis of inflammatory origin.

## GENITO-URINARY SYSTEM.

But two cases of primary nephritis have been discovered this year, one occurring in a caribou and one in an ocelot. Both cases showed the lesions of acute exudative nephritis.

Two cases of post-partum sepsis have already been considered. One case of cystitis of unknown origin, terminating in rupture of the bladder, was found in a small rodent.

## MALNUTRITION.

Eight post-mortem examinations have shown no definite lesions other than such as might be most conveniently classified under the heading of malnutrition. Two cases have died as the direct result of general visceral fatty degeneration, probably due to over-nourishment and under-exercise.

## RECOMMENDATIONS.

*Ranges.*—Although our results for the past year have been in general very satisfactory, and though they have shown a distinct improvement in nearly all classes of diseases over the results obtained in 1902, still we feel that there is much to be desired, and I should like to impress upon the Board that we are by no means satisfied with the results and particularly with the large amount of sickness which occurs among our valuable ruminants, though the death rate in these animals has been materially reduced.

There is no doubt but that the faults that cause this condition are dietetic and follow almost immediately the release of the animals into the grass ranges. This subject has already been the object of a special report in which I emphasized again, as I have in all of the reports which I have had the honor to render to your Board, the impossibility of making these ranges safe, unless all the natural vegetation be removed and in most cases at least the floor of the enclosures be replaced with an artificial one. I am fully convinced that these rules apply to all the ranges in a greater or less degree.

*Sheep Ranges.*—My ideas are embodied in a special report rendered November 29, 1903.

*Ponds.*—In all cases where mammals are quartered in enclosures which contain bodies of water, these should be so arranged that they can be drained and thoroughly cleaned from time to time, otherwise once infected they may act for a long time as a source of infection for all animals confined in that pound. We have good reason for believing that the pond in the elk range has acted in this way. Of course I realize that such radical alterations are not practicable in all instances, but in so far as possible they should be observed, and, in my opinion, it is only a question of time when we shall find it necessary to make it a general rule.

## THE OLD ELK HERD.

There is no room for reasonable doubt but that all the members of the old elk herd are infected with bronchial filaria and the *Mischerschen schleuche*. Both these parasites are transferable to other and healthy animals, so that throwing out entirely the question of consanguinity, I look on this herd as not only itself hopeless, but as an actual menace to all other animals of like nature confined within their vicinity. Of course there should be



no mingling of the animals of the new herd with those of the old, and, as I have pointed out before, the floor and pond of the elk range must be most thoroughly gone over before it will be safe to place the healthy stock in this pasture.

I would also like to suggest that from time to time new bulls from other herds be secured, perhaps by exchange, so that the well-recognized bad effects of too great inbreeding may, in so far as practicable, be obviated.

#### BUFFALO HERD.

I do not wish to add anything in regard to this herd other than the opinion given in a previous report in which I advised against the continuance of the present grass ranges.

#### HOSPITAL.

Observations which Dr. Blair has been conducting have, we believe, shown the practicability of a building designed in part for a quarantine station at which all incoming animals may be received and kept under observation for a sufficient period of time, and for a hospital in which sick and injured animals may be confined for observation or treatment. This building should be so constructed that different temperatures may be maintained in various wards for the various species of animals. Arrangement for water, light, and air should be ample, and a special provision should be made for a properly equipped operating room and surgical ward. Arrangements should be made in the same building for the laboratory with the dead house adjoining and for a pathological museum.

I sincerely hope that if the construction of such a building be undertaken, that the Board will remember that a building and a name do not make a hospital, and that the general experience in human medicine has been that the opinions of architects solely are far from the best when the question of medical utility is to be considered.

#### LIBRARY.

My report would not seem familiar to you, did I not again ask for an appropriation for the purchase of a few books each year, dealing with the subjects which bear directly on the work at the Park.

We believe that the records of the past year's work have shown the medical work of the Park to be a financial success, to put it on no higher plane, and it does not seem unreasonable for us to ask for a modest appropriation for the purchase of a few books and such few journals of comparative medicine as are published.

#### REPORTS.

It has seemed best to your Advisory Board and to ourselves, that in the future a special report be rendered to your Board dealing almost exclusively with statistical information and such conclusions and recommendations as should be brought before you alone. In addition to this official report, that an article or articles dealing more with the scientific part of our work be rendered for publication in the Report, or elsewhere, as you may wish. This will enable us to study each year some particular problem, in a more satisfactory way and at the same time will, we believe, give you more concisely the facts needed for your consideration, relieving our report from yearly repetition of almost axiomatic facts. We have attempted to follow this general plan in this year's report but shall have the matter in better hand next year.

Respectfully submitted,

HARLOW BROOKS.

NEW YORK, February 1, 1904.





PHOTOGRAPH.

ELWIN R. SANBORN.

CHIMPANZEE: POLLY.

A thriving young specimen in the Primates House.

## CAGE PARALYSIS.

By HARLOW BROOKS, M.D.

WITH A PRELIMINARY PATHOLOGICAL STUDY OF FIVE CASES.

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OF the 113 deaths which have occurred at the New York Zoological Park during the past year, five were caused by diseases of the central nervous system. These cases do not include those in which the nervous diseases were but a complication in some general or local disease, but only such instances as may correctly be classed as primary diseases of the nervous system. Thus we find that the occurrence of diseases in this class of wild animals in captivity is in about the same proportion as in man.

Of these five cases, two were of cerebral hæmorrhage, one of which was of traumatic origin and the other idiopathic. One ape died from a well-defined cerebro-spinal meningitis, in which the exudate approximated very closely that seen in human epidemic cerebro-spinal meningitis. A cheetah died with acute mania consequent upon an exudative cerebral meningitis. Two primates died from a peculiar type of spinal paralysis, known and recognized among animal men as "cage paralysis."

I have become very much interested in this condition, since it offered the opportunity to study spinal lesions in a cord of more primitive simplicity than in the human, and with the lesions in an earlier stage of development than we are able to obtain them in man.

This preliminary study is presented in this crude state since I believe that it presents the question in a general way, and apparently eliminates from our problem some by-paths into which the student might easily be diverted from the more important aspects of the question.

My knowledge concerning "Cage Paralysis" as a clinical picture has been chiefly derived from conversation with Drs. Frank Miller and W. Reid Blair, of the N. Y. Zoological Society, and Director Hornaday, with his associates of the same institution. I have also derived considerable information from conversation with various animal trainers and keepers. Through the courtesy

of Drs. Miller and Blair I have also been able to see and study a few clinical cases.

"Cage paralysis" is generally recognized by animal men as a distinct disease. The few veterinarians who have become sufficiently versed in the diseases of wild animals are also generally inclined to look upon it as an entity, though they make a distinct differentiation from certain rheumatic symptoms which uninstructed men would be very apt to call and to mistake for actual spinal disease.

*Occurrence.*—The disease occurs almost exclusively among wild animals, though a few cases are also probably seen among certain domesticated ones. It is found most commonly among the higher mammals, principally among bears and primates. Of the primates, in which the disease is by far the most frequent, the lower types, such as the lemurs, are not often attacked, though baboons, macaques and other examples of the lower monkeys are affected. In general, we might say that it occurs most frequently in those animals which habitually or commonly assume the upright gait. Its occurrence is not limited to, or more usual in, animals from any one part of the world. I have found no instances of its being found among those in the wild, and Mr. Hornaday, whose numerous observations of wild animals in their natural habitat are well known, tells me that he has never seen it in a wild animal, either free or at the time of its capture. However, he adds the very significant statement that an animal, even in the early stages of the disease, is so seriously handicapped that it would in all probability soon die of starvation or fall prey to the carnivorous animals which are generally found in the same habitat; hence, though it is rather improbable that it occurs in nature, it is still a question which will probably never be really settled.

*Sex.*—In so far as our observation goes, the disease occurs equally in both sexes.

*Age.*—The disease may appear in either old or young animals, and there seems to be no relation between age and occurrence. It does apparently affect more frequently those animals which have been in captivity a long time, and hence it is, perhaps, most frequent in old animals. Bearing on this fact, we must remember that under the usual conditions the life of many primates in captivity is perhaps fully as long as in the open.

*Etiology.*—Absolutely nothing definite is known of the etiology of the disease. By some it is thought that it is caused by exposure, but, as in the cases at the New York Zoological Park, this is excluded by an automatically adjusted temperature and by the greatest possible care. Some think that it develops as a result of the unnatural character of the floor on which the animals are

confined, but this does not seem to be well founded, since it appears alike in animals confined in the ordinary board-floor cages of the travelling menageries, in metal cages, the floor of which is covered by some soft substance, and in those which have the ground as a floor. The cleanliness of quarters does not seem to affect the etiological factors, for the disease apparently occurs as frequently in the scrupulously kept enclosures of the New York Zoological Park as in the often foul quarters of the animal dealers. Confinement in smaller cages apparently offers some predisposition to the disease, since we have observed fewer cases occurring in the larger, more airy, and best-lighted cages; most of the cases developing in the smaller and darker side compartments. Food has apparently no effect on the disease. The mental effects of restraint apparently do not act as a causative factor, for as a rule the disease occurs in those animals which take very kindly to cage life, and it does not appear more frequently in those animals which are most affected by confinement and restraint. The mentality of the animals bears no apparent relationship to the onset of the disease.

A few cases are found which have followed traumatism, but the instances have been so few as to almost lead one to the conclusion that they have always been but coincidences and that injury in reality had nothing to do with the onset. The character of the food has apparently nothing to do with the causation of the disease, for at the New York Zoological Park the food is very thoroughly inspected, and the amount and character is carefully controlled. Nevertheless it is generally admitted that the disease occurs mostly in animals which have been in captivity for a considerable length of time, and animal men, who as a rule are keen observers, are convinced that the cause of the disease is in some way connected with the effects of captivity.

*Onset.*—The first symptom generally noticed is a stiffness of the lower extremities, manifested in that the animal is not as quick and agile as usual and soon ceases to attempt the more difficult feats which the monkeys in particular are so fond of doing. This stiffness is generally more evident on one side than the other, and the actions of the animal resemble those of one suffering with rheumatism. They often continue to feed and look well, but once the initial stiffness has appeared, the disease almost always progresses with at least observable rapidity, finally affecting both of the rear extremities. During this period the animal is apparently free from pain and, if accustomed to handling, does not resent it at this time. It is not evident that pain is produced by the manipulation of the partially paralyzed extremities.

Progression is generally quite rapid, and locomotion becomes more and more difficult, until finally the legs begin to show marked atrophy. The coat of the animal becomes unkempt and rough, he ceases to feed well, and the paralysis finally becomes so marked that he can progress only by dragging the lower part of the body after him, or sometimes by swinging the legs and lower trunk between the arms, much as a cripple uses crutches.

Rarely, as in one case of this series, distinct symptoms of pain are present, but this is the exception, and the legs generally become anæsthetic, so that a pin may be thrust into them without the animal apparently noticing it.

Deep necrotic ulcerations begin to appear, usually on the buttocks where the animal habitually seats himself, but later perhaps on the feet or over the sacrum. Trivial wounds of the paralyzed legs do not heal properly, but ulcerate and slough.

In a few observations which I have made there seems to be a general loss of muscular and tendon reflexes, but it is very difficult to be certain on this point.

No mental symptoms appear, though the animal avoids his own kind, apparently fearing, not without reason, injury from them, but toward his keepers and friends he shows no alteration of temper.

In the later stages of the disease control of the sphincters is lost and the fæces and urine are passed involuntarily. At about this time the animal, apparently as a result of these general conditions, begins to fail rapidly and of course soon ceases to be a desirable specimen for exhibition and therefore is disposed of.

No cases of recovery are on record, and no measures thus far attempted have even seemed to arrest the progress of the disease, once it becomes fully inaugurated. Where subjects of "cage-paralysis" are allowed to live, they usually die from some intercurrent affection, such as pneumonia, tuberculosis, or gastro-enteritis.

*Treatment.*—Medical treatment is apparently without avail. Tonics, iron in various forms, nutritious foods and all the measures generally employed in such conditions in the human, are used here without avail. It is interesting that iodides have also been used entirely without effect.

*Pathology.*—In so far as I have been able to find in the various reports and studies from various zoological gardens, few carefully conducted post-mortem examinations are recorded and in most of these instances microscopic studies are wanting.

For these reasons we have attempted to systematically study the spinal cords of the case which have occurred in the Park,



and in this paper is a preliminary study designed to outline the subject. I have refrained in it from unnecessary details, stating as briefly as possible only the lesions bearing directly on the disease. No constant or significant alterations have been found in the general viscera, and for this reason they have not been included in this study, though a complete examination was made in each instance.

No gross lesions of the central nervous tissues were found in any case except one, where meningeal exudate was present, a point confirmed by the microscopic examination.

Since this study is intended only as a preliminary outline and not as a finished article—most of the cases not having been carefully observed clinically—the pathological studies have been but fragmentary. In the time at my disposal for the preparation of this article it was manifestly impossible for me to carefully study each of the cases, hence segments were selected from the cords, with the full understanding that an examination of each segment, of each posterior root ganglion, and of many of the peripheral nerve fibers, as well as the entire encephalon, would be necessary were the study designed to be a finished one; such minute examinations would seem wasted on material, most of which has been casually observed by the keepers of the animals and occasionally by the veterinarian. The observations are subject to the assumption that the general arrangement of the tracts and fibers is the same in these animals as in man, an assumption probably inaccurate. I am indebted for most of the gross pathological observations to Dr. W. Reid Blair of the Park.

*Technic.*—Previous experience in the study of the spinal cords of the smaller animals has taught me that the removal of the cord from its bony canal while the tissue was perfectly fresh frequently resulted in formation of serious artefacts, consequently I removed the entire spinal column in the first four of the following cases, immersing it for 48 hours in a 5-per-cent. solution of formalin, after which the bones were carefully cut away, exposing the cord more immediately to the action of the formalin. Tissues for general tissue changes were then transferred to graded alcohol, embedded in paraffin, cut and mounted in the usual manner and stained chiefly with hæmatoxylin and eosin, also with Van Gieson's picro-acid fuchsin. Sections stained with the Neisl blue were also prepared in the same general manner.

Segments intended for detection of degenerated fibers and tracts, were hardened and prepared after the method of Marchii or by the Busch modification of the same method.

## CASE I.

*Barbary Ape (Imacacus innus).*—The animal had been some time in captivity or on ship-board before being delivered to the Park.

On its arrival with a consignment of other animals the veterinarian at once noted the condition of paralysis, which seemed to be fairly typical of the picture usually presented in "cage paralysis." The animal was also found to be tubercular, hence was never placed on exhibition but was kept in the quarantine station up to the time of its death.

## POST-MORTEM EXAMINATION.

Examination made on date of death.

*Body.*—Markedly emaciated, tissues very anæmic. *Heart.*—Collapsed, flabby; otherwise apparently normal. *Lungs.*—Both lungs filled with caseous tubercular masses varying in size from a pea to a walnut. There is a small area of recent hæmorrhage in the right middle lobe. *Liver.*—Vessels congested, a few scattered tubercles are present. *Kidneys.*—Both are studded with tubercles and the parenchyma shows a general parenchymatous nephritis. *Spleen and Lymph Nodes.*—Both are much congested and are extensively tubercular. *Stomach.*—Empty except for a small amount of yellowish fluid, no food is present. *Intestine and Genito-Urinary Tract.*—Negative. *Brain and Spinal Cord.*—Gross examination of the spinal cord after it has been hardened, showed meningitis, most intense at lower levels.

## MICROSCOPIC EXAMINATION.

*Cervical Cord.*—In the upper cervical levels the pia-arachnoid shows a moderate degree of chronic thickening of the membranes, and in places the connective tissue cells of its structure show evidences of recent proliferation, particularly about the vessels, which are quite universally injected. In the lower cervical regions the membrane shows in addition a very marked serous exudate, which in places contains a good many leucocytes, chiefly mononuclear cells, but in places there are a good many polynuclear ones. The cellular exudate is most apparent about the blood vessels, which are mostly congested.

The substance of the cord shows a very general dilatation of the lymph channels, particularly of the perivascular spaces, and in some places the lacunæ in which the cells are lodged are also dilated, this without apparent shrinkage of the ganglion cells.

The vessels of the cord are injected and a few of them show a slight exudate of small round cells into the adventitia.

Sections prepared after the Marchii method show occasional degenerated fibers, chiefly in the posterior tracts and most numerous in the column of Goll. Occasional degenerated fibers are also found in the descending tracts, but nothing like a systematic degeneration is evident in them.

Sections stained with the Neisl blue, show a very general disintegration of the chromatic plaques of the ganglion cells, some of them are still evident but show lack of staining affinity, others show a finely granular disintegration of the plaques. These evidences of degeneration are very general and in some places amount to actual cytoclasis; it is more than probable that many of the alterations are of post-mortem origin.

*Dorsal Segments.*—Series of sections taken in the upper, mid and lower dorsal segments show alterations very like those described in the cervical region, except that the lesions increase in intensity as the lower levels are reached and, though altogether similar to those described in the cervical regions, are of much more marked degree. In the lowest dorsal segments the cellular exudate is found passing into the cord with nerve roots.

*Lumbar Cord.*—In some places the meningeal exudate has so infiltrated the cord that practically a condition of transverse myelitis exists, otherwise the lesions are like those of the superior portions of the cord.

*Cauda Equina.*—Sections show a very marked general small round-cell exudation about all the nerve fibers. Well-formed tubercles are frequent and in some cases have caused complete necrosis of the normal structures.

*Posterior Root Ganglia.*—Sections of the posterior root ganglia of the lower levels show also an intense productive inflammation apparently following the nerve trunks. Degenerated nerve fibers are not numerous even in those of the *cauda equina*, and from the condition of the ganglion cells it seems highly probable that at least a part of the degenerated fibers are due to a disease of the ganglion cells.

*Conclusion.*—The condition clearly originated as a tubercular meningitis and the disease apparently started in the lower portion of the spinal canal, extending rapidly upward.

#### CASE II.

*Common Macaque (Macacus rhesus).*—This animal formed one of a large group of these monkeys and was not particularly observed, except that the case was rapidly progressive.

The wasting of the muscles of the rear extremities was moderately well marked and paralysis of the extremities was complete when the animal was killed. No trophic ulcers had developed and the body was not extremely emaciated, for the animal had continued to take its food fairly well, though not so anxiously as a normal one would.

The gross examination of the cord and brain showed nothing of note, and the internal viscera were normal, except for a general deficiency in fat.

#### MICROSCOPIC EXAMINATION.

*Brain.*—Sections taken through the left motor cortex showed nothing noteworthy, except a general dilatation of the lymph spaces. No degenerated fibers are present in either the sub-cortical white matter or in the left internal capsule. *Cord.*—The membranes of the cord are normal.

*Medulla.*—Sections prepared by the Busch-Marchii method show no degenerated fibers in the pyramids, but a few are present among the arcuate fibers and in the neighborhood of the nucleus gracilis and cuneatus. A few degenerated fibers are also present in the fillet. There is general dilatation of the lymph spaces.

*Cervical Cord.*—The lymph spaces are generally dilated, but otherwise the general structure is not altered. Sections prepared by the Busch-Marchii method show a great many degenerated fibers in the posterior tracts, particularly in the column of Goll. The most radial fibers in Burdach's tract do not seem to be affected. There is also a marked general degeneration in the fibers of the direct cerebellar tract and a few scattering degenerated fibers in the antero-lateral tract, also an occasional one in the direct pyramidal and in the anterior ground bundle.

Sections stained by the method of Neisl show a general chromatolysis in the cells of the anterior horns; the alteration is so general that it is likely largely due to post-mortem changes.

*Dorsal Cord.*—Sections through the upper dorsal levels show alterations similar to those found in the cervical segments as regards the degenerated tracts, except that the column of Burdach is relatively more involved.

The mid-dorsal region presents an area of myelitic softening in which all the structures of the cord are extensively necrosed and the entire mass is permeated by extravasated blood mingled with broken-down masses of myeline.

The lower dorsal segments show extensive degeneration of the direct and crossed pyramidal tracts and numerous degenerated

fibers in the antero-lateral and the anterior ground bundle; a few scattering degenerated fibers are also present in the posterior tracts, but these columns are in general free from degenerations. The blood vessels in the gray matter are quite extensively congested and areas of myelitic degeneration are frequent.

*Lumbar and Sacral Cord.*—The degenerations present are almost exclusively limited to the descending columns.

*Posterior Root Ganglia.*—No alterations are evident above the level of myelitis. Ganglia corresponding to the area of softening show a few small patches of cellular exudation and a shrinkage of some of the ganglion cells.

*Blood Vessels.*—The blood vessels throughout the spinal cord, with the exception of the area of softening, show no apparent changes.

The case is clearly one of transverse myelitis of the mid-dorsal cord with the descending degenerations below the lesion and the usual ascending degeneration above. Aside from this the cord seems to have been normal and the cause of the myelitis is not apparent.

### CASE III.

*Vervet Monkey (Cercopithecus lalandii).*—The animal presented the general clinical manifestations of cage paralysis. Six weeks elapsed between the time of the first observation of the disease and the death of the animal. During this period the monkey emaciated moderately and progressive atrophy of the rear extremities have become marked.

The autopsy, which was performed by Dr. Blair, showed moderate general emaciation with marked atrophy of the hind extremities from the pelvis down. There was a large deep indolent appearing ulceration of the tissues over each tuberosity of the *ischium*. The *heart* was in diastole and normal. The *lungs* were normal. The *liver* was congested. The *kidneys* were moderately congested. The *bladder* was well filled with urine and was otherwise normal. The *stomach*, *pancreas* and *intestines* were normal throughout. *Brain and Spinal Cord.*—Gross examination shows no lesions in either brain or cord.

### MICROSCOPIC EXAMINATION.

*Cervical Cord.*—Microscopically, the spinal cord in the cervical region shows a considerable number of degenerated fibers in the direct and crossed pyramidal tracts and in the antero-lateral tracts.

Degenerated fibers are also found in the anterior nerve roots. Examination of the ganglion cells of the anterior horns shows very marked atrophy, in many cases amounting to actual cytolysis. Others of the cells are elongated, the chromatic plaques are missing and the cells show atrophy to a marked degree.

*Dorsal Cord.*—The descending degeneration present in the cervical segments is also present in the dorsal cord, and in addition occasional degenerated fibers are present in the columns of Goll and Burdach. The ganglion cells of the anterior horn in these levels show also the same marked degeneration as was found in the cervical regions, but the degenerated cells are much more numerous here than in the cervical levels. Sections of some of the posterior root ganglia from these levels show atrophy of certain cells, together with the degeneration of some of the fibers originating in the ganglia. The nerve trunks surrounding the cord show a good many degenerated fibers.

The blood vessels show no abnormality except in those areas of the anterior horns where the degenerated cells appear most frequent; here there seems to be perivascular gliomatosis of slight degree.

*Lumbar Cord.*—Alterations in the lumbar cord do not differ from those found in the cervical and dorsal levels.

*Conclusions.*—A descending degeneration with poliomyelitis is disseminated throughout the cord, becoming more marked in the lower levels where the posterior root ganglia are also involved, causing degeneration of isolated fibers in the ascending tracts.

It is a little difficult to reconcile the degenerations found in this cord without assuming some disease of the encephalon, and in all probability this was present. It is probable, however, that the lesions that give rise to the most marked symptoms were the poliomyelitic changes.

#### CASE IV.

*Macacus nemestrinus.*—The animal exhibited the atrophies in a moderate degree, and the disease was of rather recent onset. The animal was killed by chloroform and the general post-mortem examination showed nothing of note. No gross alterations were evident in the brain or cord.

Microscopically, the lesions present throughout the cord consisted of an atrophy and degeneration of the cells of the anterior horn, particularly in the lower dorsal and lumbar regions, but present also, though in lesser degree, in the cervical levels.

Occasional degenerated fibers were found, scattered irregularly

throughout the ascending as well as descending tracts, but no definite systematic degeneration was present.

Vascular alterations, chiefly an acute exudative arteritis, was present in the anterior horns in a few patches, and elsewhere many of the smaller vessels showed a chronic proliferative arteritis; the larger vessels seem to be free from these changes.

*Conclusions.*—This case apparently represents one of poliomyelitis of rather recent origin associated with a chronic proliferative arteritis of the smaller vessels of the cord.

#### CASE V.

*Himalayan Bear (Ursus torquatus).*—This animal was received at the New York Zoological Park showing on its arrival a partial paralysis of the hind extremities. This was accompanied by a slight atrophy of the muscles of these limbs, but the case differed from the ordinary one of "cage paralysis," in that this animal gave many manifestations of most intense sensory disturbances. If we may judge from the actions of the animal, it suffered from pains of a darting or lancinating character confined to the paralyzed extremities, and so severe that the animal in pain and anger would often turn and savagely strip the skin and muscles of the extremities with fangs and claws, so that in mercy the animal was killed by chloroform.

I am indebted to Dr. Frank Miller for the clinical observations on this case and for the spinal cord which he removed and kindly sent to me for microscopic examination.

The case differs very materially from those of typical "cage paralysis," but it has seemed best to introduce it in this series, since, except for the presence of paræsthesia, the manifestations were fairly typical of this clinically indefinite disorder.

We have been unable to obtain anything in regard to the previous history of this animal. Judging from the lesions found the condition must have been of long standing.

#### MICROSCOPIC EXAMINATION.

*Spinal Cord.—Membranes.*—The dura mater appears normal throughout. The pia-arachnoid is not thickened, but its vessels are universally congested; no exudate, however, surrounds the vessels and the condition is apparently largely passive. The lymphatics of the membranes, as well as those of the cord, contain numerous bacteria. Three varieties are most common, namely, a coccus (*staphylococcus*), a long, slim, square-ended bacillus and a spirillum. From the fact that no local inflammatory reaction ap-

pears to have resulted, I infer that the growth of these bacteria has been mostly, if not entirely, post mortem, and that it has nothing to do with the explanation of the disease.

*Vessels.*—Many of the vessels of the cord show the presence of these bacteria in numbers equal to those found in the membranes, otherwise the vessels are normal, excepting in certain gliomatous areas in the posterior column, where many of them exhibit thick and sclerosed walls; in other parts of the cord atheroma and endarteritis are entirely wanting.

*Cord.*—No marked pathological lesions are evident in the upper portion of the cord (cervical and upper dorsal) and in no parts are evidences of acute myelitis or softening found. In the lower dorsal and in the lumbar portions of the cord and, to a much less degree, in the sacral portion, a V-shaped area is found which impinges near to, but not entirely on, the peripheral fibers and extends toward the center of the cord to within from .1 to .3 cm. of the gray commissure. In this area a marked proliferation of glia is shown mingled with connective tissue hyperplasia and resulting in the formation of a firm mass of tissue in which vessels with greatly thickened walls are found. But few nerve fibers are still remaining in this zone.

This sclerosis chiefly involves the column of Goll. The general character of the lesion resembles that seen in disseminated sclerosis.

*Gray Matter.*—No gross changes are present in the gray matter. The vessels are moderately injected and there is slight dilation of the lymphatics and of the perilymph spaces.

Since the cord was not placed in fixing fluid for some hours after death, the cytoplasmic findings are not to be absolutely relied upon. The technic employed for this purpose was that of Neisl.

The cell groups are larger and contain more cells than in the human, but the general arrangement of them is as in man, and the ventro-lateral and the ventro-mesial seem to be the most prominent collections of the anterior horns. It is difficult to make out a definite arrangement in the posterior horns. The cytoplasmic alterations are about equally present at all the levels and possess the same general characteristic throughout. The majority of the cells are normal, in so far as we may judge from the results of the Neisl method. The most frequent alteration in the plaques is a coarsely granular disintegration of the chromatic bodies with a chromatophilia of the remaining plaques. Sometimes the fragmentation is final, and a few cells show chromatolysis, but the above is the most frequent lesion, and, inasmuch as it is most pro-



nounced in certain ganglion cells, which show also a few cytoplasmic vacuoles, I infer that the change may be largely or entirely post mortem.

This special stain brings out the bacteria mentioned as present in the vessels particularly well, and it is found that the lymph channels throughout the cord are literally crammed with them, principally the rod-shaped organism, which is found to contain intensely staining polar bodies which resemble spores, while the intervening portions of the rod are homogeneous.

FIBERS AND TRACTS.—(Marchii method).

*Cauda Equina*.—Sections through the *cauda equina* show numerous degenerated fibers; these are rarely found side by side, but are scattered irregularly through the mass of nerve trunks.

*Sacral Cord*.—Sections through this portion of the cord show many degenerated fibers in the posterior portion of the column of Goll, and an occasional degenerated fiber in the peripheral portion of the direct pyramids and anterior ground bundles. Sections of the nerve fibers which surround this portion of the cord show irregular degenerated fibers scattered throughout.

*Lumbar Cord*.—Degenerated fibers are present in the same distribution as that just mentioned, and many such fibers are found in the sclerosed patch which is at this level. Degeneration in the trunks surrounding this portion of the cord is more infrequent than below.

*Dorsal Cord*.—The dorsal region shows degeneration in the same general distribution, but more frequent in the anterior and lateral columns, though still most prominent in the column of Goll. Degenerated fibers in the surrounding trunks are less frequent than in the lumbar sections.

*Cervical Cord*.—The cervical enlargement shows practically identical conditions.

*Ventricle*.—The ventricle is wide open throughout, probably the normal condition in this animal.

*Posterior Root Ganglia*.—Sections stained by the ordinary methods show general shrinkage of the ganglion cells, and it is plainly evident that most of them are surrounded by a distinct cuticular membrane which is a part of the cell itself. The implantation cone is plainly seen in many of these cells. There are a few areas in which a slight exudate of small round cells is present, mostly in the region of ganglion cells, but this change is not marked, though the general condition of the tissues indicates an ante-mortem oedema to quite a pronounced degree. (This change was noted in the gross.) Sections stained by the Neisl method show that nearly all the ganglion cells have degenerative altera-

tions. This consists in most instances of a finely granular breaking down of the plaques without resulting chromatolysis, but in a few cells this change is often present, when it is generally of a somewhat patchy character. A few cells show vacuoles, clearly a post-mortem change. The cuticular membrane of the cells does not stain, but appears sometimes finely granular and sometimes clear. There is no apparent alteration in the ganglion cell nuclei or nucleoli.

*Conclusions.*—The lesions of this case may be summarized as posterior sclerosis with disseminated patches of sclerosis and chronic arteritis, chiefly confined to the posterior columns in the lumbar and lower dorsal cord, resembling very closely the lesions found in disseminated spinal sclerosis or the late lesions of *tabes dorsalis*. The alterations in the posterior root ganglia also simulate *tabes dorsalis*. In some respects the changes may be said to strikingly resemble those in human spinal syphilis.

For the reasons mentioned in the text, it does not seem likely that the bacteria found in the sections bear any relation to the lesions found. In so far as the sequence of lesions is concerned, nothing is determined, unless we assume the vascular alterations to be primary and the changes in the nerve tissues secondary to them.

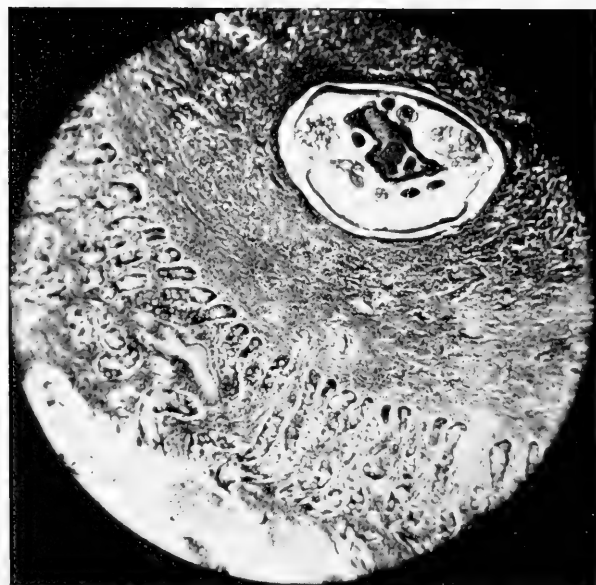
#### GENERAL CONCLUSIONS.

From these fragmentary observations it seems evident that "cage paralysis" as noted by animal men is not a true disease entity, but that it covers many types of paralysis, mostly of spinal origin and probably as numerous as the like conditions in man.

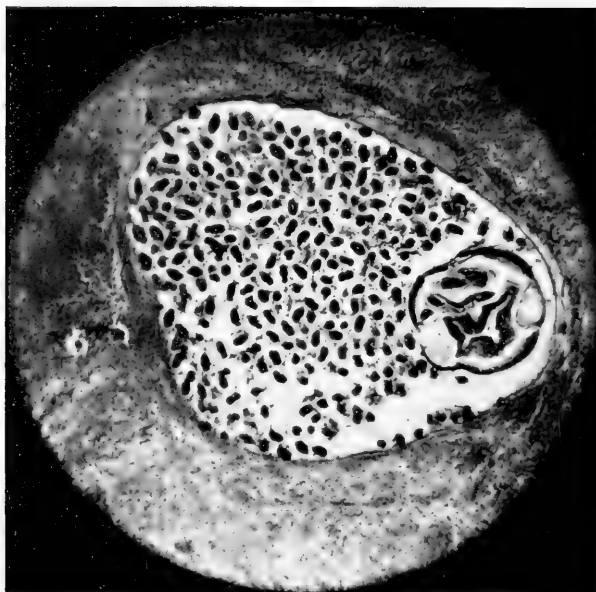
From the five cases outlined in this study it seems that the lesions very closely resemble those of similar and well recognized human diseases. It is therefore reasonable to expect that careful study of the tissues of these animals, killed in the early stages of the disease, may throw much light on the evolution of the same class of disease in man.

Concerning the causation of these spinal paralyses in wild animals in captivity, the present study determines nothing, except that the causative factors, like the lesions, are probably variable: but it has clearly shown that a more accurate clinical study of these animals is necessary and must precede or accompany pathological investigations. With the absolute control of every condition surrounding these animals (after their capture) in our power, we should be able in the course of a few years to collect some data of definite value in regard to the etiology of these diseases.





CROSS-SECTION SHOWING SCLEROSTOMA IN THE MUSCULAR TISSUE.



CROSS-SECTION SHOWING PARASITE WITH EMBRYOS,  
MICRO-PHOTOGRAPH OF THE COLON OF AN ORANG.

## INTERNAL PARASITES IN WILD ANIMALS.

*By* W. REID BLAIR, D.V.S.

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THE frequency of the occurrence of parasitic diseases, particularly those due to nematode intestinal worms, has led me to devote a considerable amount of time to the investigation of the worms infesting our various animals. The fact that each parasite or group often demands a different management establishes a greater call for a thorough study of the subject. In order to deal with parasites so as to cut off their sources of survival, and extirpate them from a locality, a fuller knowledge of their life history is demanded than for simple parasitocidal medical treatment. From our experience, I am led to believe that parasitic diseases are an important factor in the death rate of probably all zoological collections. This is perfectly natural. In nature a wild animal roams over a considerable surface of ground, and the infection it spreads is therefore widely scattered; in a zoological garden, this infection, with eggs and embryos of parasitic worms passed in its droppings, is necessarily confined to a small area: hence small ranges, corrals, and cages are naturally areas of concentrated infection. Therefore, the mortality of animals and birds due to parasitic worms, particularly to nematodes not requiring an intermediate host, will be a factor with which we shall always have to reckon.

Considering the great fatality among young canines and felines caused by worms, not alone of the greatest importance is the treatment after their existence is obvious, but treatment for prevention is demanded with equal urgency. Probably no known disorder to which the Canidæ or Felidæ are subject is so destructive as intestinal worms. It has been estimated by reliable authorities that at least three-fourths of the whole canine race is infected more or less seriously by them.

Among the many different species of internal parasites, some are found in the liver. The cruel threadworm selects the heart of its victim, death resulting suddenly in a convulsion, or it may be deferred for a time, during which the animal is racked by agonizing pain. In the nasal cavities, the lungs, blood and muscu-

lar tissues, parasites have been found. In fact, scarcely any portion or tissue of the body is free from intrusion. Parasites belong to such numerous different types that it is quite important that the complete dissimilarity of parasitic types and their relationship to others should be appreciated.

In dealing with parasites such as certain filaria found in the lungs of elk, deer and buffalo, which require an intermediate host or bearer, it is important to remember that the existence and gravity of a parasitism often depends quite as much on the favorable conditions of the environment as on the presence of the parasite itself.

Any injurious parasite will tend to increase to a deadly degree of prevalence when present in a given locality, in which the numbers of its natural hosts are very great, and in which other conditions conduce to its preservation and increase. If, for instance, it must pass a certain stage (embryo, larva) in water, then wet lands, marshes, pools, lakes or sluggish streams are a necessary condition. On the other hand, if the larva, as in the case of certain tænia (*T. canina*), lives in an invertebrate skin-parasite of the same host, then the existence and maintenance of the intestinal or other parasitism is dependent on the presence of the cutaneous parasitism. So with the hundreds of other conditions varying with the parasite, the host, and the environment, and, as a rule, these conditions must be changed before we can hope to get rid of the parasitic invasions.

Practically all parasites are capable of propagating and developing with marvellous rapidity, a single female sometimes producing hundreds, or even thousands, in a very few days. Most of them possess inherent vitality, and particularly is this the case with the eggs and embryos. They possess the power of resisting a certain amount of heat and cold and desquamation, and will even withstand some chemical agents.

During the last year the systematic and regular treatment of lions, tigers, leopards, pumas, lynxes, bears, wolves, and foxes, and such smaller mammals as badgers, ocelots and other members of the Felidæ which subsist largely or entirely on a meat and fish diet, by administering vermicides and vermifuges at certain regular intervals has, in my opinion, been of the greatest importance in keeping these animals free from the intestinal disorders so frequently produced by intestinal parasites.

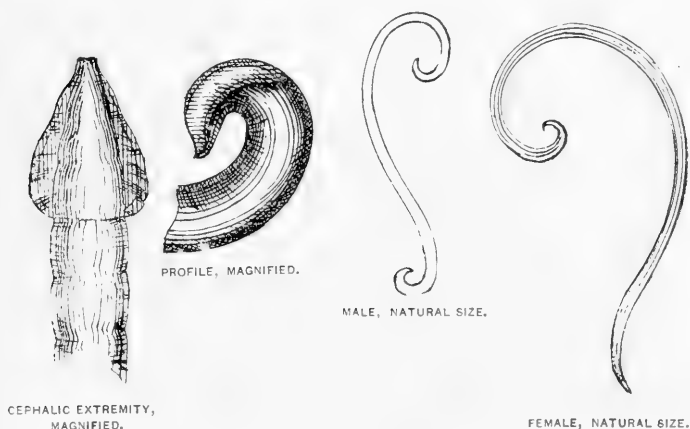
The morbid effects of worms infesting the Canidæ and Felidæ cannot be exaggerated. I believe that the epileptiform convulsions or fits, so often seen among young wolves, foxes, ocelots and

other meat- and fish-eating animals, are due, in the great majority of cases, to the irritation produced by intestinal parasites.

Following is a list of parasites most commonly met with among our animals, nearly all of which are amenable to treatment:

*Ascaris mystax* (Zeder).—*Female* measures 5 cm. to 10 cm. long; *male*, 4 cm. to 6 cm. This species is very commonly found in the Felidæ generally—tigers, lion cubs, ocelots, martens and badgers. Its distinguishing features are well shown in the accompanying cut.

*Ascaris marginata* (Rudolphi).—This worm is white, or slightly reddish; head is curled, and has three lips with papilla on each.



ASCARIS MYSTAX (RAILLIET).

*Female*, 8 cm. to 14 cm. in length; tail obtuse. *Male*, 5 cm. to 10 cm. long; tail is curled, and possessing two small membranous lateral wings. They have been found in tigers, leopards, coyotes, wolves and foxes.

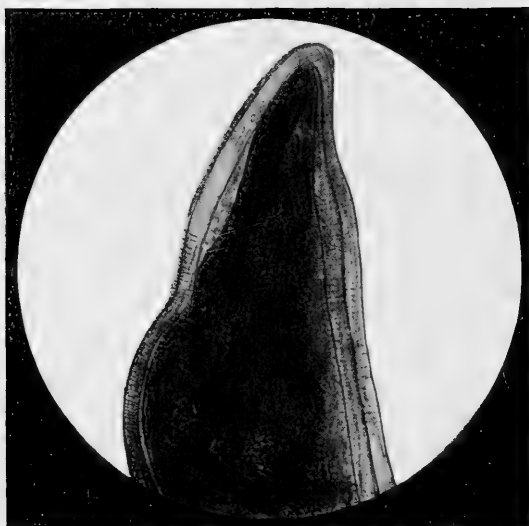
*Ascaris megaloccephala*, of the horse, has been found in bears, wolves, and zebras. *Male*, 12 mm. to 18 mm. long; *female* considerably longer. A female worm obtained from a zebra measured  $14\frac{1}{2}$  inches after being in formalin for more than a week. The presence of these worms does not usually affect the health of their host, although in young animals they might give rise to various digestive disorders.

*Ascaris lumbricoides*.—*Female*, 12 mm. to 24 mm. in length, and about 5 to 7 mm. in diameter; the *male* is considerably smaller.

This common parasite of the human intestine has been found



HEAD.



TAIL.

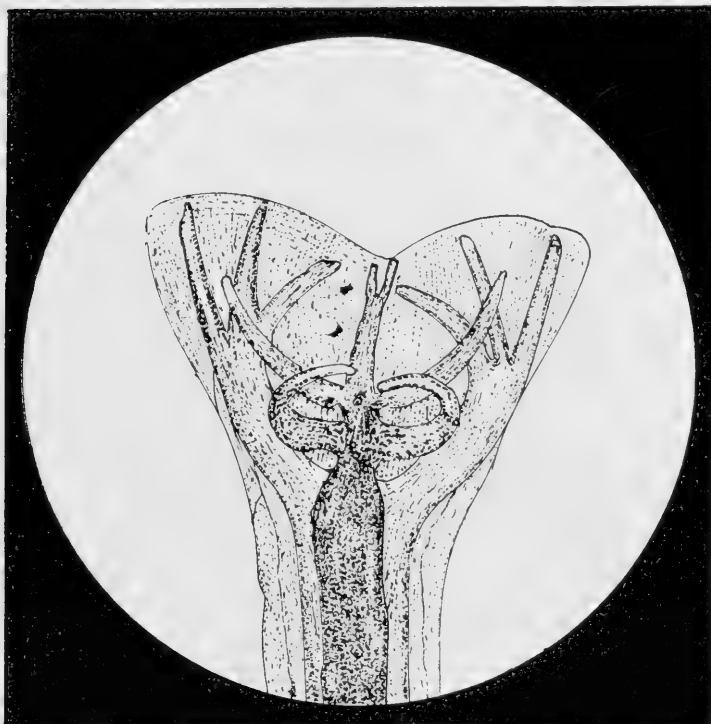
DOCHMIUS TRIGONOCEPHALUS, FEMALE.



in an orang-utan, and also in a chimpanzee, in which they occurred in such numbers as to cause a fatal intestinal obstruction.

An unidentified *Ascaris* from a black leopard (*Felis pardus*). This parasite resembles the *Ascaris lumbricoides* of man, but is somewhat smaller in diameter, but fully as long.

*Dochmius trigonocephala* (*Uncinaria*).—Male, 9 mm. to 12



DOCHMIUS TRIGONOCEPHALUS, MALE

Caudal pouch magnified.

mm. long; *female*, 9 mm. to 15 mm. long; caudal pouch trilobate, the middle lobe being slender; tail of female obtuse; eggs ovoid.

This parasite has, I understand, been very disastrous to a recent importation of blue foxes (*Vulpes lagopus*) from Alaska in one of our prominent American zoological gardens.

Only two cases of this troublesome worm have come under my observation among the Park animals.

Of these cases, one of them was a Mearns' coyote, on autopsy.

from the record of which I will partially quote:—"Carcass has the appearance of general anæmia and marasmus. Extreme pallor and bloodlessness of the various mucosæ with areas of congestion and marked infiltration and thickening. The villi are enlarged to several times their normal size. On the small intestine, especially, the ilium mucosa are deep red hæmorrhagic spots, in which the worms, in greater or lesser numbers, are found attached by their mouths to the mucosa. The whole muscular system is anæmic, soft and flabby. The blood is lacking in its rich, healthy, deep red color, and hydræmic, with a deficiency of red globules. Œdema and softening of the lymph glands of the mesentery is a marked feature."

This parasite has been very prevalent during the last year or two among dogs kept in kennels in New York City and the immediate vicinity. Unlike the genus *Ascaris*, which subsists by absorption of the host's intestinal contents, this parasite exists by extracting its nourishment directly from the host's blood, by attaching itself to the mucous membrane by hook-like spikes with which it is provided.

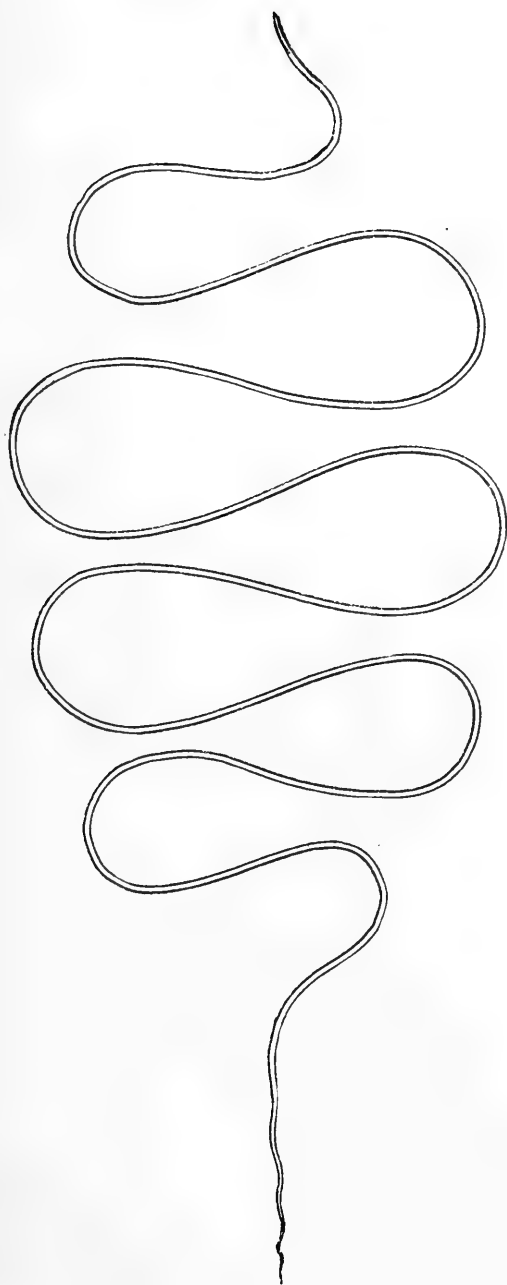
In these animals it gives rise to a fatal anæmia, known as "malignant enzootic anæmia." It is interesting to note that this parasite, or one closely allied, *Dochmius duodenale*, is the recognized cause of the disease in man known as "Egyptian chlorosis."

Dr. Brooks has kindly given me two specimens of *Dochmius duodenale*, for comparison. These were obtained from the intestine of a Puerto Rican. On microscopical examination, I was unable to note any characteristic differences between it and the parasite of the fox and coyote.

Owing to the unsatisfactory results obtained from vermicides in the treatment of this parasite among domestic animals, the means of prevention is obviously of the greatest importance. This affection is one that may easily be mistaken for essential, non-parasitic anæmia; so that in order to make an absolute diagnosis, a microscopic examination of the fæces should be made after the administration of anthelmintics, which should result in the discovery of ova of the *Uncinaria*.

Leuckart has studied the evolution of the *Uncinaria trigonoccephala*, and it appears to be analogous in its general characters to that of the *Ankylostoma* of man.

The vitellus of the ova, segments in the oviduct of the female until it reaches the larval stage: their evolution is probably not continued in the intestine of their host, but after their expulsion with the fæces. The cycle is completed in the presence of suitable



FEMALE, NATURAL SIZE.



MALE, NATURAL SIZE.

*FILARIA GRACILIS* (RUDOLPHI).

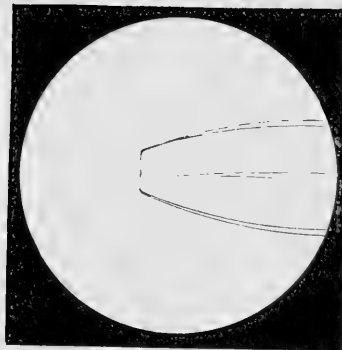
heat and moisture. The period occupied in this development varies according to the environment, but on incubating in water at a suitable temperature an embryo soon becomes visible in their interior, and hatching is completed in two or three days. The larvæ that issue from the ova are 300  $\mu$  long and 95  $\mu$  broad; their posterior extremity is elongated into a tapering tail; in developing they moult two or three times, and attain adult condition after passing with the water into the intestines of their host, without requiring an intermediate host. Eight days after this passive migration they are 5 mm. to 1 mm. long, and in certain details resemble the definite form. On the tenth day the old chitinous integument is shed, the buccal capsule appears, and it is only now that the group to which the parasite belongs is recognizable. It retains this form for three or four days, during which it acquires its final dimensions, and a second moulting results in the parasite acquiring its sexual individuality.

These details, and particularly the essential part that water plays in the evolution of this parasite, show that infestation probably takes place through the medium of the drinking water, and that the hosts contaminate each other by scattering the ova of their parasites in the water-troughs. This shows the necessity of having elevated drinking places, so as to reduce the infection of animals from this source to a minimum.

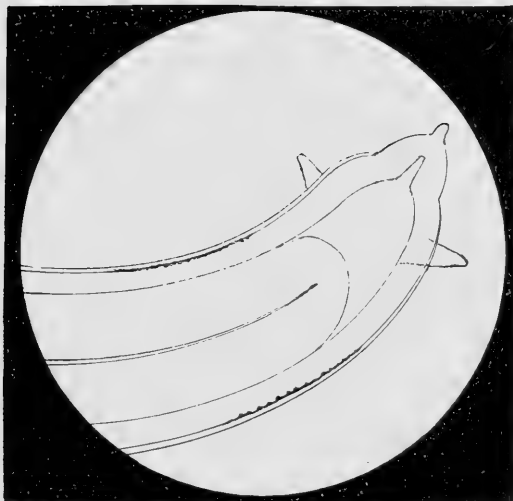
The genus *Filaria* is a very large and important one. Like *Ascaris*, it is confined to Vertebrates, but usually lives in the tissues of the body and not in the intestines. Several rare members of this genus have been found among the Park animals.

*Filaria gracilis* (Rudolphi).—Fourteen specimens of this nematode were found in a spider monkey (*Ateles*); one of this number was partially encysted in a false sac formed by the costal pleura. Two more were quite firmly adherent to the pulmonary pleura on the left side. Seven or eight were found in the abdominal cavity, five of which were situated between the folds of the mesentery of the small intestines. One was found coiled around the portal vein, while several were found in the mesenteric blood vessels. Owing to the extreme rarity and great length of this nematode, I think it is of sufficient interest to warrant a short description.

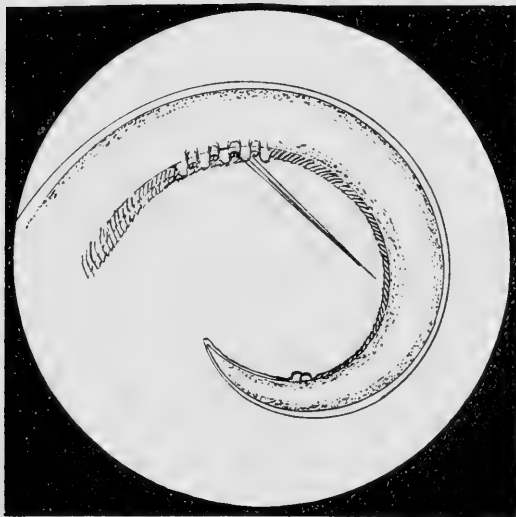
Prior to this writing I am not aware that this worm has ever been found in this country. However, a number of preparations of this *Filaria* are reported to be in the Museum of the Royal College of Surgeons in London. Some of these specimens were originally obtained by Professor Owen from the pleural cavity



CEPHALIC EXTREMITY.



CAUDAL EXTREMITY, FEMALE, MAGNIFIED.



CAUDAL EXTREMITY, MALE, MAGNIFIED.

FILARIA GRACILIS.

of a capuchin monkey, others having been found by him in the thorax of an orang-utan. The distinguishing features of this nematode are its extreme length and nearly uniform thickness throughout, only slightly attenuated at the cephalic end, the caudal extremity, however, gradually tapering for about an inch, terminating in a fine point.

Female longer than the male, 7 to 14 inches for the female. All the males which I examined were under  $6\frac{1}{2}$  inches. A single female has been reported over 20 inches in length. The tail, as shown in the accompanying cut, is furnished near its extremity with three conical papillæ. The actual extremity of the tail has an exceedingly minute prominence, with a centrally placed duct.

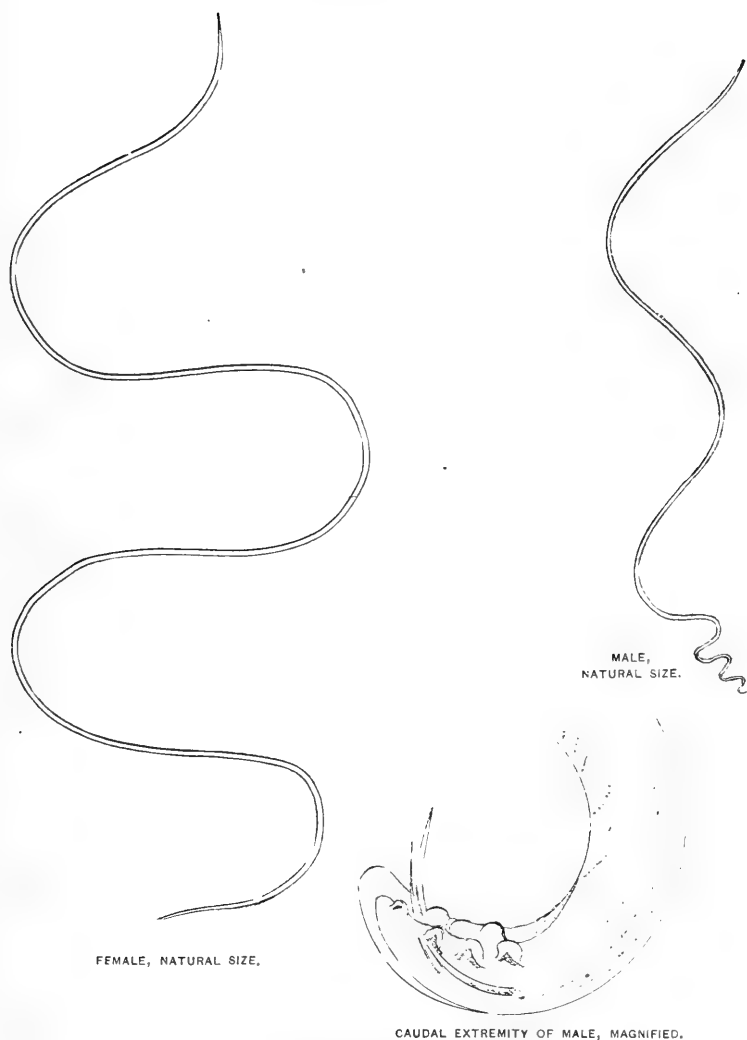
*Filaria immitis* (Leidy).—The cruel threadworm of the Chinese has been found among our animals in a number of instances (sea-lions and wolf). While this *Filaria* is commonly found in man and dogs in China, and the East generally, it is not, however, unknown in America and Europe. It occasionally occurs in such large numbers in the right side of the heart and pulmonary artery of the dog that it is difficult to see how the circulation can proceed.

The *Filaria immitis* does not often betray its presence by any distinct recognizable systems during the lifetime of the infected animal; though its existence may be predicted on finding embryos on a microscopical examination of the blood. In the majority of instances the worms are found at the autopsy of animals which have died after various morbid manifestations.

Death is usually sudden, or has only been preceded for an hour or two by dyspnoea and convulsions. Frequently the animal has exhibited for a variable number of days dullness, debility, local dropsies, and more or less frequent attacks of convulsions or epileptiform seizures. The immediate host of this parasite is still obscure, but from the prevalence of the disease appearing in countries particularly rich in marshes and surface-water, the host might therefore be supposed to be some aquatic animal.

It is interesting to note in this connection the occurrence of the parasite in our California sea-lions, that live exclusively on fish. The female worms are usually more numerous and of greater length than the males. Of the fourteen filariæ found in the right ventricle of a sea-lion, only three were males.

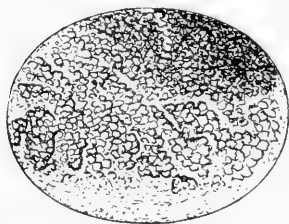
Several of the worms which I examined microscopically contained an enormous number of ova, enclosing embryos in various stages of development. Manson noted a habit of these embryos of abounding in the superficial blood vessels during the night and



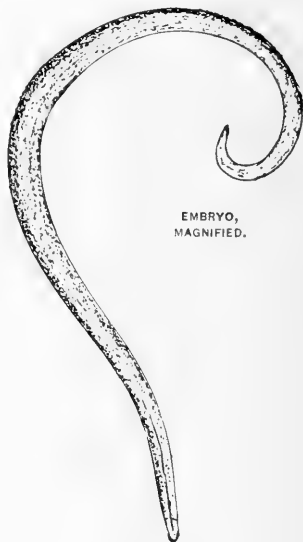
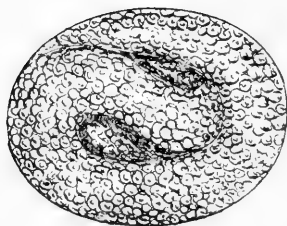
FILARIA IMMITIS (LEIDY).

retiring to the large vessels of the chest and abdomen during the day, after the manner of the *Filaria sanguinis hominis*. In the heart they are usually found wound around the *columnæ carnæ* and *cordæ tendinæ*. I have also found them in the pulmonary artery and its ramifications in the lungs.

To the naked eye the sexual differences are readily discernible. The female maintains almost throughout a uniform calibre of 1 mm., but at the cephalic end it diminishes to about .5 mm. and at the caudal extremity to about 1-100 inch, the extreme point being bluntly convex. The oviducts of the female are usually crowded with eggs. The largest eggs contain coiled embryos. The male parasite is readily recognized by its comparatively slen-



EGG, MAGNIFIED.

EMBRYO,  
MAGNIFIED.

EGG CONTAINING COILED EMBRYO.



MALE AND FEMALE, NATURAL SIZE.

#### STRONGYLUS FILARIA.

der body, having a diameter of about 1.2 mm., and also by its spirally curved tail, which is three or four times twisted upon itself with the regularity of a corkscrew. The coiled portion is much narrower than the body of the worm, gradually becoming attenuated to the breadth of 1-300 inch, the extreme point, however, terminating bluntly as in the female.

*Strongylus filaria* and *Strongylus micrurus* are the species of nematodes found in the bronchia and lungs of our American elk



and European red deer. The *Strongylus filaria* is the one principally found, however. It is a very long filiform worm, of the thickness of stout cotton thread, somewhat attenuated at the extremities and of a white color. The *male*, 3 cm. to 8 cm. long; *female*, 5 cm. to 10 cm. long. Upon examination of the female under the microscope, the ovarian coils are usually found to be filled with eggs, oval in shape, .01 mm. in length and containing well-formed embryos. When the ovum is laid the well-formed embryo soon escapes. It is not known to undergo further development in the bronchia, but if expelled and thrown into water or moist earth, the egg or embryo may remain alive for months. (Baillet).

Leuckart, who experimented quite extensively with this particular nematoid, failed to produce the disease in healthy sheep by feeding them the bronchial mucus rich in ova and embryos. He found that in the second week of their existence in water, or moist earth, they moulted. He even supposed that they moulted a second time and infested an invertebrate host; but of this there is no actual proof. He also found that if kept in water many died soon after moulting. I have never succeeded in keeping the adult worm or its embryo alive in water at any temperature longer than 2 to 4 days. Ercolani found that if the embryos were dried up after moulting, they could be preserved for a year and revived when again subjected to moisture. While water seems to be essential to the preservation and moulting of the embryo, yet a drought following such moulting might preserve it indefinitely by drying it up, and arresting vital changes without destroying its vitality.

The worm undoubtedly enters the body through the medium of green vegetation, earth or water. Just how it reaches the lungs—whether by the larynx, in connection with deglutition and rumination, or by means of the circulatory system—has not yet been certainly determined.

It is the unanimous opinion of all observers that the conditions favoring the disease are *wet seasons*, as in the case of worms generally. The abundance of water favors the preservation of the embryo, and also its moulting, which fits it for a new internal habitat. Grazing on *marshy pastures*, *pools* and *sluggish streams*, or *inundated lands* are especially favorable to the preservation of the worm, and hence its frequency in countries like Holland and Belgium, and in all damp lands that have once become infested.

*Impaired health from previous or coexistent disease, or from lack of stamina due to inbreeding, must be recognized as predisposing to the disease by lessening the power of resistance.*

Owing to the unsatisfactory results obtained from medicinal treatment of this disease among domestic ruminants, it is of obvious importance to prevent the spread of the disease as much as possible. Prophylactic measures then are the means by which we must expect the best results. I am of the opinion that thorough burning of the contaminated ranges, adequate drainage, and isolation of infected animals, will bring such outbreaks to an end.

Diagnosis is principally based on the occurrence of the disease simultaneously in the majority of the herd, without apparent exposure or meteorologic cause, on the knowledge of the existence of the parasites in the ranges or locality, on the damp or otherwise favorable condition of the ranges, and on the *importation* of new animals from infected localities, and positively by the examination of the expectoration of muco-purulent matter containing adult worms, embryos or eggs.

*Symptoms.*—Symptoms are those of bronchial irritation. The cough is at first hard, but after a time it becomes more frequent, soft and mucous, or wheezing; the animal becomes hide-bound, with rough coat, absence of subcutaneous fat, stunted growth of antlers, progressive emaciation and weakness. The animal finally isolates itself, dying by asphyxiation or marasmus.

*Lesions of Verminous Bronchitis in Elk.*—The trachea and bronchia contain an abundant frothy muco-purulent secretion containing great numbers of wriggling filaria, which are often found rolled up in bundles of sufficient size as to completely fill up the lumen of the tube. The mucosa of the affected bronchi is usually congested, reddened, thickened and softened, or even desquamating. The bronchia shows dilatations at intervals filled with the verminous *débris*, ova, embryos, and mature worms. Lobular congestion of the lungs is frequent. In advanced cases acute lobular pneumonia is present, while at certain other points particular lobules are collapsed as the result of blocking of their bronchia, and expulsion of the air. The body shows a general atrophied condition, blanched mucosa and anæmia, and loss of subcutaneous fat.

#### SCLEROSTOMES.

Several interesting *Sclerostomes* have been found among our animals.

*Spiroptera megastoma* (Railliet).—Found in the small intestine of a clouded leopard (*Felis macrocelis*) from Sumatra. This parasite is described by Neumann as belonging almost exclusively to the stomach of the Equidæ, where they form round promi-

nences. Male, 7 mm. to 9 mm. long; tail obtuse, rolled in a spiral manner and bearing two lateral wings, each sustained by five papillæ and two unequal spiculæ; female, 11 mm. long; tail straight; ova oblong.

In the intestine of the leopard the tendency of the tumors seemed to form colonies, 8 to 10 of these occurring from  $\frac{1}{2}$  to 1 inch apart, and then perhaps none occurring for 7 to 8 inches. The color of these tumors did not differ from that of the adjacent parts, and they were rather firm in consistence. On their summit were one to two, sometimes three, perforations that communicated with the irregular cavity. These tumors were situated between the mucous and muscular layers of the intestine. When the tumors are old their contents are concrete and their walls fibrous. In these are found worms or their *débris*. Whether they multiply in the tumors, or submit to migration, is not definitely known.

In the case of this leopard, the parasites were so abundant as to give rise to hæmorrhagic enteritis and dysentery.

The *Sclerostoma* found inhabiting the colon of an orang-utan was the causative factor in giving rise to a chronic hæmorrhagic dysentery. The tumors they formed beneath the mucous membrane were of the same general character as those of the *Sclerostoma tetracanthus* which inhabits the cæcum and colon of the Equidæ. The parasite itself, however, differs considerably from that of the *Sclerostoma tetracanthus*. Plates show sections of this encysted parasite in the muscular coat of the bowel. They are probably introduced into the intestines with the water the host drinks, and it is very likely that they encyst themselves directly in the mucous membrane, without penetrating the circulatory system—at least, no wandering parasites of this kind have ever been observed. When the tumors are old their contents are concrete and their walls are fibrous. In them are found dead worms or their *débris*. In certain of these tumors I found a single adult worm 5 mm. to 6 mm. long, and several much smaller worms about 3 mm. in length; while in other tumors the adult worm alone was present. That the parasites multiply in the tumors is evident, but just when the young worms submit to migrations is not definitely known.

#### SYMPTOMS OF INTESTINAL WORMS.

The symptoms denoting the existence of worms within the intestinal canal are in some instances obscure, in others prominent. At times but little derangement is noted, at others profound disturbances result.

The more common symptoms observed among our animals are the following: Considerable abdominal distention or bloating, vastly disproportionate to the amount of food taken; voracious or depraved appetite, manifested by eating all sorts of foreign bodies, sticks, stones, bedding, etc., thirst, and an offensive odor to the breath; intermittent abdominal pains, vomiting, diarrhoea, and a rough, dry, harsh coat, with gradual emaciation.

#### TREATMENT.

A very large number of drugs have from time to time been recommended for intestinal parasites; but many of them have an unwarranted reputation, and it is best to employ only those the efficiency of which has been well established.

After carefully noting the effects of a number of parasiticides and vermifuges on the various animals, I am convinced that the safest and at the same time the most effectual remedy for the round worms infecting these animals is santonine, alone or in combination with the æthereal extract of male shield fern (*Oleoresina aspidii*) in properly graded doses. For tapeworm, oil of areca-nut is most effectual. This oil should be freshly prepared as needed. It is prepared as follows: Take three ounces of freshly-ground areca-nut and six ounces of olive oil. Place in a wide-mouthed bottle and thoroughly mix, remove to a warm place and macerate frequently for 48 to 72 hours, and then allow it to settle. Decant the oil, which is now ready for use. The dose of this oil for a large animal, like a polar bear, is from two to three ounces, given preferably in a pan of milk, after the animal has been prepared by fasting for 48 hours, or at least on an empty stomach. As the object of treatment is primarily to expel the worms, it is very important that remedies shall reach them readily and find them in a somewhat famished condition.

In many instances it is better that the anthelmintic treatment should be preceded by half-diet for a number of days. A purgative may be added to the vermifuge, in order to expel the worms which have been killed or stupefied.

I have found, in such cases, that calomel, in small doses, is both efficacious and entirely safe. Occasionally it may be found that remedies which in some cases are effectual, are in others inactive. For this reason, when there is positive or presumptive evidence of the existence of worms, absolute dependence should not be placed upon any one agent, but others be given after a proper interval has been allowed. In giving medicines for the destruction

of worms, certain precautions in feeding should be observed. If a single dose of a drug is to be depended upon, food should be withheld until after the bowels have moved freely. If, however, the drug is to be continued three or four days, the diet should be simple and as limited as the condition of the animal will permit, and allowing as long an interval as possible between the feeding and the administration of the medicine.

A very valuable and safe remedy for *Ascarides* in very young or delicate small animals weighing one to three pounds is worm-seed oil. This should be given in doses of one to four drops. It is well to combine the remedy with a drop of oil of aniseseed or oil of peppermint, well mixed in a teaspoonful of cod liver oil or castor oil, or it may be given in a little warm milk.

#### PREVENTION.

As the *Ascaris* develops in the bowel directly from the ovum or embryo, taken in with food or water, without requiring an intermediate host, every effort must be made to prevent its admission by these channels. Fæcal matter, charged as it may be with the parasites and their eggs, may find its way into the drinking water or feeding vessels, and infect healthy animals.

While it is true that we do not know the precise mode of introduction of a great number of parasites, we are yet not altogether at the mercy of their invasion. For them, as for the others, their germs are certainly derived from without; and it is evident that our animals can be rendered absolutely safe from them, if we can ensure the rigorous cleanliness of their surroundings and various hygienic agencies. But it requires continual, fastidious and patient care, which is generally so often neglected, and only comes into notice when circumstances have demonstrated the manner and seriousness of an invasion.

I wish to express my thanks and acknowledge my indebtedness to Mr. George M. Beerbower for the several excellent drawings of parasites contained in this article.

## OBSERVATIONS ON LACERTILIANS.

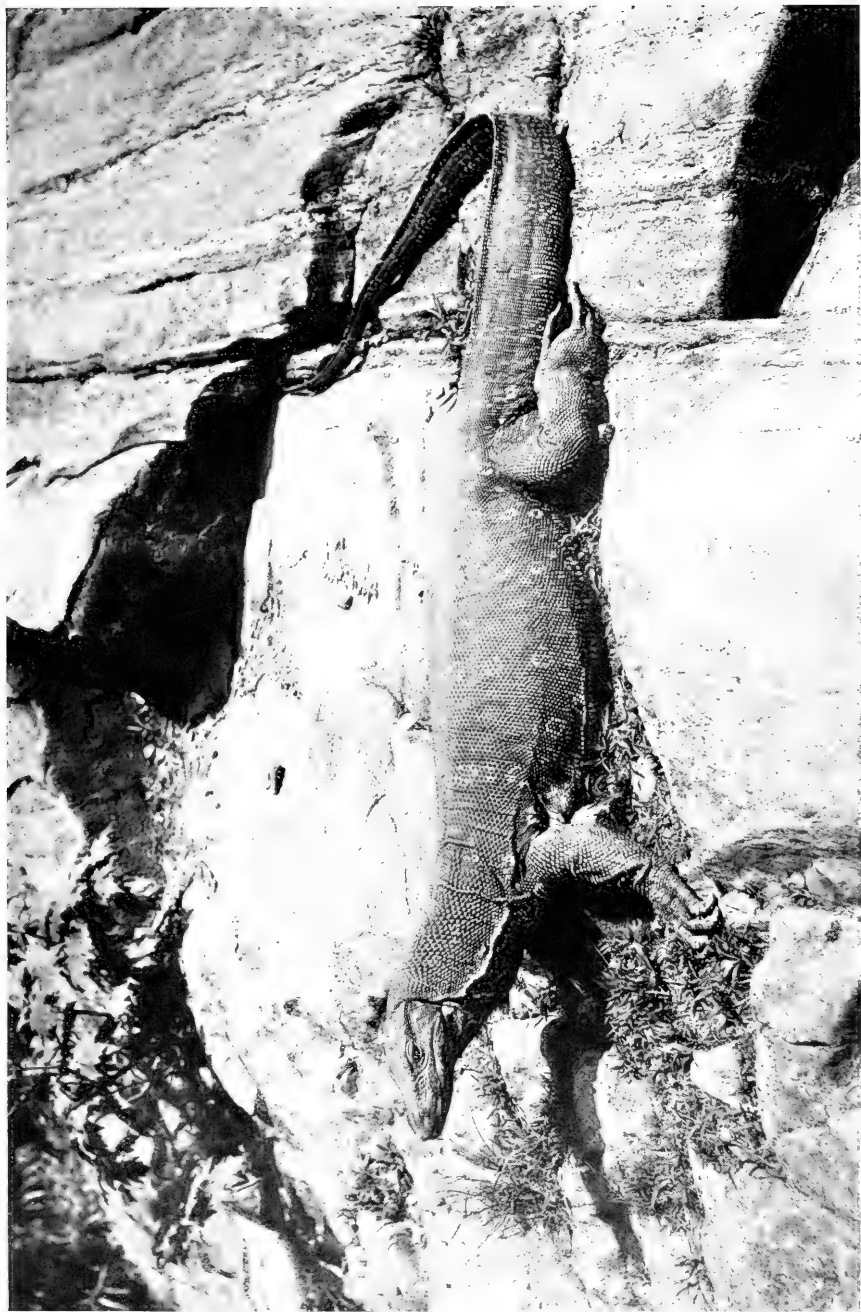
By RAYMOND L. DITMARS,

CURATOR OF REPTILES.

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OF the class of reptiles, the Order of *Lacertilia* presents the most remarkable variation in anatomy and habits. As an example of this, the species of the South American genus *Amphisbæna* may be compared with the Old World monitors. In the former we have limbless, worm-like, half-blind creatures, which timidly burrow away from the light in mouldy ground or decaying trees. These lowly and helpless forms of reptile life would appeal to the popular mind as more distinctly removed in classification from the monitors than the latter are removed from a bright-eyed and highly-colored snake. But those worm-like creatures, and the bold, dashing monitors, with their great size, and powerful limbs and claws, all belong to the Order of Lizards. Thus we have in these forms a variation in anatomy and habits from feeble, insectivorous and burrowing creatures to those that run swiftly, and possess strength of jaw sufficient to crush the life out of the small mammals that constitute their food. There are 1,893 species of lizards, evincing many curious phases of form and color.

The collection of lizards in the Reptile House of the Zoological Park has been made valuable and interesting only by the diligent and constant efforts that have been made to obtain representative species from various parts of the world. The larger lizards have been represented by such species as the Marine Iguana, Rhinoceros and Crested Iguana, four species of Monitors, the Frilled Lizard and the Gila Monster. The smaller species of particular interest in the Eastern Hemisphere have been represented by the African Chameleon, various Geckoes, the Giant Cyclodes, Mastigure, Green Lizard, Viviparous Lizard, Sand Lizard, the Blind "worm" and Sheltopusic. The collection from the Western Hemisphere has contained various species of Horned "Toads," the lizards of the Western deserts, the Blue-Tailed Lizard, Six-Lined Lizard, Swifts of several species, the Anolis or American Chameleon, and the Glass "Snake." With such a thorough representation of the *Lacertilia* constantly on hand, the writer has had exceptional



PHOTOGRAPH.

CEYLONESE MONITOR.

The largest lacertilian in the Reptile House.

ELWIN B. SANDRIN.





opportunities for observing the characteristics of these interesting creatures.

#### COLOR CHANGES.

Certain lizards have always evoked popular interest because of their colors and color changes. These characters are especially noticeable in members of the family *Chamæleontidæ*, and certain species of the *Iguanidæ*. The families evincing this variation of hues among their species are among the minority. Such forms as the *Scincidæ*, the *Lacertidæ* and the *Anguidæ* show no intimation of this character. Although the marked changes of color occur in species possessing a fine, granulated scalation, there are many species with large and well-developed scales, either smooth or carinated, that momentarily vary in their hues. Usually, however, the variation in such individuals consists of an intensification of a definite and permanent pattern, or the fading of the same. An example of such species is the common Swift (*Sceloporus undulatus*) and its allies. Patches of pale gray on the abdomen and throat will assume the most brilliant shades of blue, while the pattern on the creature's back varies from a series of transverse dashes of gray to the same pattern in brown or yellow.

It is not the writer's idea to describe these color changes from a realistic standpoint, but rather to note the actual effects produced upon several species by certain conditions. The common Chameleon (*Chameleon vulgaris*), of Africa, is an interesting illustration. Numerous experiments have been conducted with these lizards in the Reptile House, and the following is a list of observations made upon them:

*Specimen No. 1* was placed in the sunlight in such a position that only one side of the creature was exposed to the brilliant rays.

*Specimen No. 2* was placed at an angle to the sun so that its rays suffused the entire reptile.

*Specimen No. 3* was placed in a perfectly dark box in a temperature of 75° F.

*Specimen No. 4* was placed in a dark box in a temperature of 50° F.

After a quarter of an hour's time the following results were noted:

*No. 1* was dark brown on the side exposed to the sun, and a pale brown mottled with green on the shadowed side.

*No. 2* was of a yet darker brown than *No. 1*.

*No. 3*, when uncovered, emerged in a brilliant coat of green.

*No. 4* crawled sluggishly about his chill quarters, showing a uniform pale gray.



PHOTOGRAPH.

AFRICAN CHAMELEON.

ELWIN R. SANBORN.

Noted for its remarkable color changes.

These experiments were several times repeated, and with the same results. Thus we may presume that *light* and *temperature* are among the factors conducive in altering a reptile's hues.

The next test was in the direction of ascertaining whether or not the lizards are sensitive to the colors of objects over which they move. The specimens were separated and placed in several cases, all with a corresponding degree of illumination. In one case was a branch of green leaves, in another a number of dark, leafless twigs, and in the third, fine white sand had been spread. In these quarters they were left for an hour. The results were decidedly negative. All of the lizards took on a shade of yellowish brown, causing each individual to differ quite materially from its surroundings. Repeated experiments in this line tended to prove that the colors of a reptile's surroundings have little to do with its own eccentric variations.

Fright or excitement produces a marked effect upon these creatures, the majority of which acquire lighter shades. When enervated through lack of nourishment (and these reptiles show a great reluctance to feeding in captivity), the body becomes irregularly splashed with pale colors. Traces of green will show on a gray body ground, and immediately after death patches of black appear. A peculiar instance of the effect of sunlight and shadow was observed upon a specimen that was basking under a wire grating of coarse mesh. Becoming frightened at the approach of the writer, the lizard changed its position. Its dark

brown body was brilliantly imprinted in pale yellow with the outlines of the mesh, where the shadow from the wire screen had rested on the reptile. This pattern faded away within twenty seconds.

The common colors of the Chameleon are grayish brown, green with irregular patches and spots of a lighter shade, or, when exposed to moderately strong sunlight, brown with ocellæ of green or yellow. From these phases the creature varies. To sum up our observations on this lizard, it appears that the changes of color are influenced involuntarily mainly by *light*, *temperature*, *excitement* and the *health* of the individual. Few chameleons exhibit a definite color pattern. Indistinct stripes, spots and ocellæ come and go with the changing shades of the body.

Rivalling the Chameleon in abrupt changes of color is a North American lizard, the Anolis, also called "Chameleon" (*Anolis carolinensis*). In its agility this little creature exhibits a marked contrast to the African reptile, and it is a highly interesting and easily procured example of the character under discussion. Being an inhabitant of an area where changes of temperature are frequent, and likewise so prolonged that the reptile hibernates during the colder months, it does not appear to display the sensitive color changes due to temperature, as noted in the Old World Chameleon. Light and excitement, however, strongly affect this reptile. The writer has observed two male specimens, previously a velvety brown as they sported in the sunshine, suddenly approach each other and engage in combat, which with one terminated in the loss of the larger portion of its tail. Within half a minute after the fighting began, which was accompanied by an energetic bobbing of heads and frequent dilations of the throat fan, the participants had become a beautiful shade of emerald green. On watching the victor as he triumphantly strutted along a fence rail with the writhing tail of the victim in his jaws, it was noted that the green soon faded. Dropping the souvenir of battle, the reptile settled down to rest and bask, and within two or three minutes after the fracas it had faded to a dull yellow, which soon gave way to the sober brown first noted.

In collecting these lizards and placing them in wire-covered boxes, the writer has invariably noticed their change from a variety of shades prior to capture to the same emerald hue in a scrambling collection of several dozen individuals. If the collecting box be laid down for a few moments and left undisturbed, the lizards acquire a brownish tint, but as soon as the box is again carried about, and the occupants become shaken up and frightened, the brilliant green appears on all. When sleeping, this liz-

ard assumes a pale green tint, with the under surfaces of the body and limbs white and immaculate.

#### FEEDING HABITS.

Owing to the great variability of anatomical characteristics, the feeding habits of lizards differ greatly. They may, in consequence, be divided into several groups for the convenience of description. Some species are omnivorous.

*Carnivorous Species.*—Under this head the Monitors come first in importance. Four species have been on exhibition in the Reptile House, namely: the Ceylonese Monitor (*Varanus salvator*); Yellow-Bellied Monitor (*Varanus flavescens*); Gould's Monitor (*Varanus gouldii*), and the Brown Monitor (*Varanus griseus*).

The feeding habits of these species are very similar. The Monitor's method of attacking a small mammal resembles more the actions of warm-blooded animals rather than those of reptiles. Rushing for the ill-fated creature at a speed that rapidly overtakes it, the lizard seizes the quarry and shakes it in much the same manner as a terrier treats a rat. If the creature struggles so violently that there is a possibility of its escape, the reptile holds it to the ground under its powerful claws, while the jaws take a firmer hold, and the shaking process is renewed. The prey is killed quickly, and if it is small, the reptile tosses it about in its jaws until the head points down the throat, when it is swallowed in the same manner that an owl consumes a mouse or a scrap of meat—by a series of quick, reaching gulps. If the prey is large and heavy, it is dropped to the ground and picked up carefully by the head, when the swallowing process is the same, though more prolonged and difficult. The fine, large specimen of *Varanus salvator* that has thrived for several years in the Reptile House, is frequently given a full-grown pigeon, which is killed immediately before placing it in the Monitor's cage. With but little difficulty the reptile swallows the pigeon entire. This specimen, like all the Monitors, is voraciously fond of eggs, and will take from eight to ten hens' eggs at a meal, swallowing them entire, and with such rapidity that the eggs come in contact with one another in passing down the reptile's throat, and produce a clicking sound that is quite audible to any one standing near. Within twenty-four hours the gastric juices have so disintegrated the shells that they are broken by the compression of the reptile's stomach, the contents of the eggs are digested, and the shells entirely dissolved. Besides small mam-



Photo by J. S. S. S.

THE TEGU

A South American species with striking color markings.



mals, birds and eggs, the Monitors will eat lizards and snakes. These reptiles are entirely carnivorous.

The Tegu, or Teguxin, of tropical South America, is another carnivorous species exhibited in the Reptile House. It differs from the preceding reptile by its lack of agility. This lizard is fond of eggs, but does not swallow them entire. It breaks the shell in its exceedingly powerful jaws, and laps up the contents, an operation for which it is well provided by the possession of a broad, forked tongue. The tongue is covered with minute papillæ, to which the substance of the egg readily adheres, and is thus conveyed into the creature's mouth. This lizard will also eat young birds and mammals, and is insectivorous as well. Structurally it is ill provided for the chase of active prey. Strictly carnivorous species form a small minority of the Lacertilians.

*Insectivorous Species.*—Lizards of insectivorous habits constitute the majority of the *Lacertilia*, and in securing their food they employ many methods.

The Anolis (*Anolis carolinensis*), of the Southern States, is provided with broad, adhesive digits, and by leading an arboreal life it is able to feed largely upon flying insects (*Diptera*), for the capture of which it is well fitted. Its method of procuring its prey resembles the stealthy, stalking manœuvres of the feline animals, followed by a quick rush when within a distance that make capture possible. The writer has many times watched these little creatures hunting along sunny spots where flies are numerous, and noted their great caution in approaching the quarry. After carefully stalking to within a few inches of the insect, like a cat stealing toward a bird, the lizard pauses and prepares for a rush. Such is the momentary tension as it prepares to dart forward, that the little creature may be seen to quiver in the intensity of preparation. So surely does it calculate, and so agile is the movement, that the insect rarely escapes. When the prey is captured it is well crushed by an irregular and snappy mastication before it is swallowed. The lizards of the Family *Geckonidæ* possess adhesive pads on the digits, and stalk insects in the same fashion as the Anolis.

Many of the thick-tongued lizard swallow their prey in the rapid fashion of the frogs. The Horned "Toads" are an example of that manner of feeding. In fact, these lizards pick up their prey by a quick protrusion of the glutinous tongue, and swallow it with a gulp in exactly the same fashion as the toad.

The insectivorous species which are not provided with suckers, or adhesive foot pads, produce more noise with their claws in progressing, and feed less upon the dipterous insects. They ap-

proach their food with a scampering rush, and feed largely upon beetles and their larvæ, which they hunt in the crevices of bark. These species also feed largely upon ants.

The true Chameleon, of Africa, affords an exaggerated example of the manner in which many insectivorous lizards secure their food. The specimens in the Reptile House, always exceedingly sluggish in making their way among the shrubbery of their cage, are supplied with mealworms, grasshoppers and flies. Approaching an insect with an air of great deliberation, a Chameleon regards it steadfastly for a few seconds with one rolling eye, while the other indifferently examines other objects. A sudden dart of the long tongue follows, to a distance nearly equal to the length of the reptile's body, and the morsel is snapped back into the lizard's jaws, where it is well crushed by the sharp teeth before being swallowed.

*Omnivorous Species.*—Under this head come a number of Lacertilians that have generally been credited with herbivorous habits. There are few, if any, exceptions of these alleged strictly herbivorous lizards that do not continually vary their diet with insects, and even larger prey. The Iguanas serve well to illustrate this characteristic. It has been the custom in the Reptile House to feed the common Iguana (*Iguana tuberculata*) with such tender vegetables as lettuce and celery, besides various fruits. The cages being overcrowded, several species of insectivorous lizards were placed with the Iguanas, and it was soon noted that the latter showed an equal enthusiasm for the insect larvæ and earthworms provided for the smaller reptiles as for their own vegetable food. Investigation soon demonstrated that they were fond of small birds and mammals. The experiments continued, and proved conclusively that certain species of Iguana, particularly the large *Metopoceros cornutus*, or Rhinoceros Iguana, and the *Iguana delicatissima*, preferred the carnivorous diet, and moreover displayed in obtaining it an amount of agility and voracity equal to the strictly carnivorous monitors.

A number of the smaller species of the *Iguanidæ* in the Reptile House have been observed to be omnivorous. Interesting observations were made of the Collared Lizard (*Crotaphytus collaris*), and the Leopard Lizard (*C. wislizenii*)—two Lacertilians interesting in many ways—the former from its peculiar habit when alarmed of running erect on its hind legs for a distance of twenty-five feet or more, after which curious performance it drops upon all-fours and darts over the ground with an amazing show of speed. These lizards are largely cannibalistic in their feeding habits, but they are also herbivorous and insectivorous.





RHINOCEROS IGUANA.  
An omnivorous West Indian lizard.



PHOTOGRAPHS.

ELWIN R. SANBORN.

#### GILA MONSTER.

This species inhabiting the Gila River valley, and another found in Mexico are the only known species of poisonous lizards.



tivorous. It was not unusual to observe them swallowing lizards of two-thirds their own size, as well as small snakes. Quantities of grasshoppers and crickets were placed in their cases; and to prevent those insects from eating the ornamental plants, the blossoms of red clover were strewn about as food for them. Instead of selecting the grasshoppers, the lizards turned their attention to the clover blossoms, which they greedily devoured. It was ultimately noted that they fed upon insects also, but not to a great extent, although they displayed a fondness for large ants.

The snake-like lizards of the Family *Anguidæ* have been noted as partly omnivorous, feeding largely upon insects, and also taking earthworms and slugs, young birds, and eggs. The larger species prefer the latter to any food that can be offered in captivity. The various skinks feed much the same, although none of our specimens could be induced to take earthworms. Certain species of the large Family *Agamidæ* are both herbivorous and insectivorous, although the vast proportion evince the latter taste alone. Examples of this family that display omnivorous habits are the Mastigures (*Uromastix*), which seemingly take either vegetable or insect food with equal voracity. The vegetable food of such lizards is partially masticated before being swallowed.

The Gila Monster (*Heloderma suspectum*) may be placed under the head of omnivorous lizards, as in captivity it feeds almost exclusively upon eggs—the food which most certainly cannot form a large proportion of its nourishment in a wild state. Our captive specimens never have been induced to take other food than eggs, either boiled or raw, the latter sometimes mixed with chopped meat. Unless mixed with eggs they will not eat meat. With stolid indifference they refuse morsels that are dear to the ordinary reptile of their size, such as very young rodents, large grubs and mealworms. Ants and their eggs are said to furnish a large proportion of this reptile's food, but all the specimens under the writer's observation have refused them. They have lived with us for four years, and have thrived upon their simple and unvarying diet.

#### EFFECTS OF CAPTIVITY.

Some lizards thrive indefinitely in captivity; others, owing to an insufficiency of sunlight, and to conditions found only in their native haunts, are delicate, and although feeding readily, live but a short time. Compared with snakes, they suffer more keenly the change brought about by confinement. The most hardy lizards are the carnivorous species, for, like the serpents,

they are indifferent to the presence of sunlight, provided the temperature is high. Between 75° and 85° F. constitutes a temperature in which Lacertilians flourish. The omnivorous species evince a like disposition, but eventually die of enteritis.

The most delicate of the lizards are the insectivorous forms, and the vast majority of them require a continued flood of sunshine during the day to awaken them to activity and appetite. In a wild condition these smaller lizards seek the sun from the time its rays first strike the ground until it sinks among the trees. To these active, diurnal creatures the sun is one of the most important factors of life. Without its light they are dull and sluggish, no matter what the degree of temperature. Thus it is that these creatures of the light are difficult to maintain in captivity. Some are more hardy than others, but captive quarters can at best be but a poor imitation of their natural haunts. During the few hours that sunlight streams into their cages they lie flattened on the sand or boughs, drinking in the warm light, and so greatly enjoying the abbreviated pleasure that often they fail to feed properly. The wild insectivorous lizard hunts most of the day, and under normal conditions consumes daily a large quantity of food. Its activity demands this, and the feeding of an inactive captive specimen slowly but steadily produces enervation. The creature survives for a time, but eventually succumbs to malnutrition, brought about by a lack of variety in its insect food. During the few hours of light and activity, the food is gorged hastily, and the alternate sluggish condition of the reptile, when the sunlight has gone, produces imperfect action of the digestive apparatus. Such insectivorous species as the *Anguidæ* or snake-like lizards, which care not so much for the sunlight as to burrow after their prey, thrive for many years in captivity.

As captives the larger lizards become very tame, and show considerable intelligence, although their interest seems invariably associated with appetite. Whenever their cage doors are opened the monitors in our Reptile House always approach them and nose about their keeper, with their long, forked tongues playing at frequent intervals. Frequently they will climb over the keepers' back and shoulders, in good-natured curiosity. The sight of a rat or bird throws them into a frenzy, and they take such objects from the keeper's hand with a display of ferocity that is quite startling compared with their former quiet demeanor.

Outside sunlight and air have a remarkable effect upon these "tame" reptiles. During the past summer it was decided to place the monitors in a large cage outside the Reptile House, that they might enjoy the sun. The largest specimen, a Ceylonese mon-



PHOTOGRAPH.

ELWIN R. SANEDIN.

#### AUSTRALIAN MONITOR.

A fine specimen nearly 4 feet long, which has lived 2 years in the Reptile House.



itor, nearly six feet in length, was easily carried out as it clung to Keeper Snyder's body in a position to suggest a good-natured embrace. Following the big fellow came three monitors about four feet long, which clung to the men's coats by their long claws. All these specimens had become exceedingly docile, and fed readily from the hand. It is interesting to note the change that occurred within twenty-four hours' time.

On the day that followed the placing of the monitors in the outside air, Keeper Snyder went into their enclosure to feed them. He was startled to hear a sharp hiss from his big pet of many months, the Ceylonese monitor, and to behold that powerful reptile puff himself up in angry fashion, and make a quick sweep with his tail. The powerful caudal extremity of the lizard struck the pan of eggs carried by Mr. Snyder and sent the contents flying in various directions. On looking at the other monitors, the keeper was amazed to see nothing but hostile glances as they backed away in surly fashion.

Returning later in the day to ascertain if the food had been consumed, Mr. Snyder was attacked by the big monitor, which came at him with open mouth. When only a few feet distant the reptile threw its body sidewise, and with an amazingly quick blow of its tail struck him on the arm, inflicting a long and severe contusion. This hostile action was accompanied by vigorous hissing from the other monitors.

So long as they remained outdoors these lizards continued to be wild and savage, and when brought into the Reptile House on the approach of the cool autumn nights, were very decidedly vicious. Gradually, however, they lost their wild demeanor and finally became as docile as ever. This instance of the monitors is by no means the only case noted by the writer wherein tractable captive specimens reasserted their wild nature with a rush when placed under the influence of outside air, sunshine and natural surroundings. He has noted the same disposition on the part of crocodilians and snakes, particularly poisonous species of the latter.

The most interesting demonstration of this mental change has been in connection with specimens of the venomous Gila Monster. In their cages, these lizards are the personification of good-nature, permitting themselves to be handled in the most uncereemonious manner, without the least show of bad temper. Removed to a sand-pile heated to a high temperature under a bright sun, and left for a few moments, they become different creatures. They will snap viciously from side to side, and resent the least intimation of interference with sharp hisses as they lie



PHOTOGRAPH.

ELWIN R. SANBORN.

## HORNED "TOAD."

Several species which inhabit our Western deserts.

open-mouthed, awaiting an opportunity to close with bull-dog tenacity upon an offending object. On several occasions when endeavoring to extract poison from these lizards, the writer has been unable to provoke them to bite, but after giving them a sun-bath for a few moments had considerable difficulty in disengaging their jaws from the glass vessel in which the fluid was collected, although the temperature of the outside air and sunlight which had aroused such hostility differed but slightly from the warm air of their indoor cages.

While discussing the effects of captivity upon the Lacertilians, the writer is prompted to explain the results of his experiments with Horned "Toads" (*Phrynosoma*), which although possibly not strictly germane to the subject is nevertheless of interest. These investigations were made to discover if possible the extent to which the various species of Horned "Toads" evince the alleged remarkable habit of ejecting jets of blood from the corners of the eyes, when annoyed. Various disputes have arisen over the possibility of this occurrence. Over two hundred specimens, representing different species, were examined. These were teased and provoked most persistently by the writer and the keepers, but without result. Their general attitude at such times was to feign death, with closed eyes. They seldom attempted to bite, but when placed on the ground would make off with a great show of speed.



During these investigations Mr. Otto Eggeling, of this city, received a consignment of five hundred horned lizards, and with the idea that from this large number there should be some display of the habit—if it existed—he transferred them from one box to another, with vigorous handling. Mr. Eggeling states that although some struggled energetically to escape from his grasp, some feigned death, and a few made feeble efforts to bite, no jet of blood was ejected from a single individual. Subsequently Mr. Eggeling has received other shipments of Horned "Toads," aggregating a total number examined of about eight hundred, and thus far he has failed to observe a single instance of the interesting performance that has been accredited to these creatures. With eight hundred of these lizards examined by Mr. Eggeling, and over two hundred by the writer, it appears that over a thousand specimens of these lizards, representing principally the species *Phrynosoma cornutum*, *P. coronatum* and *P. blainvelleri*, have passed careful observation with no exhibition of the very eccentric habit referred to. It therefore appears that the performance described by Dr. O. P. Hay (Proceedings United States National Museum, XV, 1892, pp. 375-378) must be limited to a very small proportion of these creatures, or was accidentally elicited by some unique measure not practised during our investigations.

#### BREEDING HABITS.

In their breeding habits the lizards resemble the snakes, though a much smaller number of the former are viviparous. Many Lacertilians alleged to be viviparous cannot strictly be so classed. Although their eggs possess a very thin and soft covering, they are actually deposited some days before the young appear. The *Scincidæ* are examples of this character, and although when deposited the eggs contain rapidly developing embryos, they are hidden away with the same precautions as the eggs of species which take a much longer time to develop and hatch. The *Lacerta vivipara* of Europe is a good example of the strictly viviparous lizards. The young emerges in a thin, translucent membrane, through which it breaks a few hours later.

It has not been the writer's idea to compile the various comments that have been made on the breeding habits of Lacertilians, some of which appear very vague and theoretical, but rather to describe actual observations of these reptiles as noted in the Zoological Park.

The Gila Monster (*Heloderma suspectum*) constitutes a good



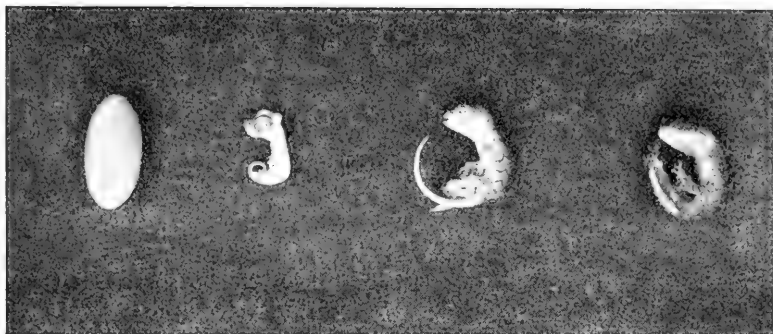
PHOTOGRAPH.

ELWIN R. SANBORN.

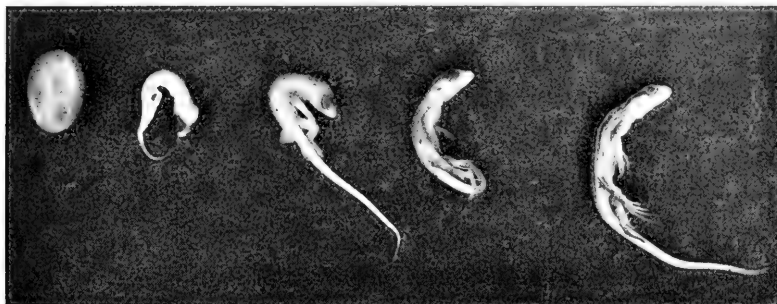
## GLASS SNAKE.

Typical representative of the family Anguillidae.

type of strictly oviparous lizard. The eggs are very large in proportion to the reptile's size. A specimen in the Reptile House measuring nineteen and one-half inches deposited four eggs, each of which measured two and three-quarter inches in length and one and one-half inches in diameter. These eggs were fertile, but in such a primary state of development that they contained nothing but a germinating spot to represent the future embryo. Incubation in warm sand produced further development, but at the end of two weeks the leathery integument covering the eggs began to shrivel, and despite the moistening of the sand and various precautions taken to complete the growth of the embryo, their contents solidified. From our notes concerning this species it would seem that the number of eggs deposited is always small, varying from three to five, a condition noted of many of the North American lizards. The largest number of eggs deposited by any North American lizard in our Reptile House was twelve, from a Swift (*Sceloporus undulatus*).



DEVELOPMENT OF THE SWIFT.



DEVELOPMENT OF THE SIX-LINED LIZARD.

Photographs show the eggs, and the various stages of development of the embryos during an interval of six or eight weeks ; at time of deposition of the egg, it contains a well-formed embryo.



PHOTOGRAPHS.

EGG OF THE GILA MONSTER.

ELWIN R. SANBORN.

Photograph of an egg from a specimen in the Reptile House.

Several notes have been made relating to the family *Anguidæ*. A specimen of the European Blindworm or Glass "Snake" (*Anguis fragilis*) gave birth to twelve living young. These snake-like creatures were born in thin sacs, in the same fashion as viviparous snakes, which they immediately pierced, and within a few days after birth were eating small earthworms. The mother displayed no interest in her offspring. This is the only species of the snake-like Lacertilians that the writer has observed to be strictly viviparous. The common Glass "Snake" (*Ophisaurus ventralis*), a reptile of the southern United States, belonging to the *Anguidæ*, deposits about a dozen eggs covered with a thin, soft integument, which at the time of oviposition contain well-formed embryos. Such eggs hatch in less than half the time required for the development of eggs of the strictly viviparous species. Similar habits have been noted in the Five-Lined Lizard (*Eumeces quinquelineatus*) of the eastern United States. Eight specimens in the collection deposited eggs in their cases under strips of bark. The eggs varied in number from two to four, and possessed a very thin covering. In direct opposition to the writer's experience with other lizards, this species evinces a unique but energetic interest in its own eggs. Each female specimen coiled herself in serpentine fashion about them, and remained in this position, declining all food until they hatched, which in some instances occurred in the short period of three weeks after being laid. When the young emerged, the parent took no notice of them.

By their habits in reproduction, lizards may be separated into three groups, as follows: First, the strictly oviparous species; second, those species which deposit eggs with *thin* integuments containing rapidly developing embryos; and third, the truly viviparous forms, which produce fully developed young. On account of the variations noted in the incubation periods of different species, the second group shows a relationship to the viviparous group.

Generally speaking, lizards deposit a much smaller number of eggs than snakes. Regarding the breeding of the Lacertilians, much remains to be learned, but owing to the frailty of many of these creatures in captivity, however, their life histories are difficult to determine.





CLAPPER RAIL.

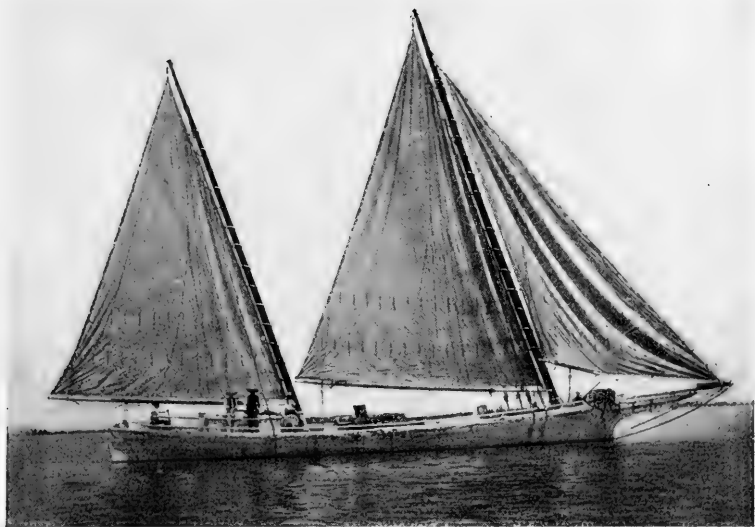
NESTS OF THE VARIOUS SEA-BIRDS.



LAUGHING GULL.



CLAPPER RAIL. NEST ELEVATED.



THE BUG-EYE.

## FIVE DAYS AMONG THE BIRDS ON COBB ISLAND, VIRGINIA.

*By* C. WILLIAM BEEBE,

CURATOR OF BIRDS.

*Illustrations from Author's Photographs.*

FROM Labrador to Florida, on the islands and beaches washed by the waves of the Atlantic, a splendid series of birds lay their eggs and rear their young. The narrow limits and comparatively uniform character of their breeding-grounds make this class of birds exceedingly susceptible to the sentiment prevailing among the nearest human inhabitants, favorable to their existence or otherwise. Their abundance or speedy extinction is absolutely under human control. For this, and for many other reasons, they are among our most interesting birds.

Before the advent of Europeans our littoral birds were doubtless all but immune from danger at their breeding-places. Hawks made raids upon them, and bears and Indians, searching for turtles' eggs, may occasionally have wrought havoc among the beach nests. Christopher Columbus saw flocks of birds and took hope

from them long before land was sighted. Captain John Smith, when he visited the "laughing king of Accomack," stirred them from their nests along the Virginia coast, and Sir Henry Hudson saw the shores of New Jersey and Long Island peopled with thousands of gulls and sea-swallows.

The reduction of these beautiful creatures to a pitiful remnant, has for its cause the robbing of untold thousands of their eggs for food, and the worse craze for adornment which has sacrificed cart-loads of breeding birds, to gratify an instinct of woman, harking back to savagery.

Birds of inland woods and fields have myriad places to choose from for nesting sites, but favorable places within sight of the great ocean are fewer in number, and, as a natural result, great colonies of sea-birds are found nesting close together in certain favorite localities, six or eight species sometimes laying their eggs in close proximity. When, to the desire for a safe place for their eggs, we add the strong instinct of these birds to return each year to the islet or bit of beach on which they were hatched, we realize that these chosen localities are to the birds something as our native country is to us. These brave birds of the sea will cling to the few yards of pebbles or sand, flecked with their eggs, with a persistence (what matters whether we call it patriotism, or love of home, or mere instinct!) which endures until perhaps the last survivor of the colony perishes. Or if left undisturbed and encouraged, their numbers will increase until overflow colonies arise near by, and the shore for scores of miles to the south and to the north are enlivened by the incomparable beauty and grace of their form and flight.

What a pity we cannot begin our list with mention of the flocks of thousands of scarlet flamingoes which formerly built their adobe mound-nests on the coral mud-flats near Cape Sable, Florida! All have disappeared, and only a remnant cling to the little-known outlying islets of Cuba and the Bahamas.

The brown pelicans which glean their living from the emerald waters of the whole eastern coast of Florida, focus upon a single islet in Indian River. No one knows how long this colony has been in existence, but, after passing through the throes of robbery and slaughter, the mute appeal of the birds and the thought of the irreparable loss which the extinction of these birds would mean to the Florida beaches and bayous, has influenced legislation, and the birds are now safe forever under the protection of the United States Government.

Passing northward, we find among the low marshes and sand-



dunes of the Virginia coast another haven for wild sea-birds, but one which they now hold with difficulty. Black skimmers, laughing gulls and various species of terns are here found nesting in colonies close together. Continuing to the north, we find small scattered colonies of sea-birds here and there, notably on Gardiner's and other islands at the eastern end of Long Island. On the former island, whose owners for thirteen generations have given the birds protection, several hundred fish-hawks build their nests within the radius of a few square miles. On the Maine coast, where the intelligent sympathy of the inhabitants is readily enlisted, large colonies of herring-gulls and other birds are established, while we may complete our brief and imperfect review with the Bird Rocks in the Gulf of St. Lawrence, where, among other species, gannets, auks, puffins and murrees lay their eggs on the ledges and among the crevices of the steep cliffs.

This brief mention of the principal bird colonies of our Atlantic sea-coast will show what a charm will be added to our shores when these birds are so protected that they will form a winged chain extending without a break from the far north to Florida, and even throughout the entire year, for when our sea-swallows and smaller gulls go southward in the fall, herring gulls and other northern species take their places.

The visits we had paid to Gardiner's Island and Pelican Island [*vide* Z. S. Bulletins, Nos. 11 and 12] only made us the more eager to visit other colonies, and when an opportunity presented itself to study the homes and habits of the birds along the Virginia coast, we were delighted to be able to take instant advantage of it.

During the past summer, in company with some friends we were able to spend a week sailing from island to island along the Virginia coast, we were delighted to be able to take instant advantage of the interesting birds which make the cedars and sand-dunes their home. We were able in this way to study intimately the nesting habits of some dozen of our sea-birds, besides observing many other species.

It was after nine o'clock on the evening of July eleventh when the sleeper moved out of Jersey City, and yet the first rays of the next morning's sun are reflected to us from the waters of Chesapeake Bay, as we leave the car at Cape Charles. A drive of six miles across country shows the familiar roadside nature of Virginia at its best. The notes of cardinals and bob-whites come to us from every side. Shadows of soaring buzzards pass over the backs of the horses, purple martins and kingbirds swoop across

the road. Pine trees are everywhere, and from their needles great crested flycatchers scream and tiny gnatcatchers twang their little ditties. In every field are young birds just out of the nest, calling for food, or struggling with the rudiments of flight. Through and around the whole scene the songs of mocking-birds come to us. Before passing out of earshot of some master singer whose melody absorbs our whole attention, another songster comes within hearing, pouring out a low, soft murmuring, like the undertone of humming insects in our northern fields. The cares of nesting and feeding the young had not silenced these superb musicians.

The fauna of the southern part of the small peninsula comprising Northampton County is interesting as being included in the Louisiana faunal area, so that although so far north, such typically southern birds as the yellow-throated warbler and brown-headed nuthatch are found here in summer.

After breakfast at the home of the guide, we leave the pines behind us, and passing through lines of fig-trees, covered with their ripening fruit, we reach the marshy shore. Here a hundred yards of wading is necessary to reach a rowboat, and a half mile of poling before we can climb on board the sixty-foot schooner, or "bug-eye" as the Virginians call it.

Then follows an eighteen-mile sail through scenes as interesting as they are novel to us. We thread our way past island after island, some dry and covered with gnarled cedars where herons nest, or a few scattered pines on whose topmost branches ospreys have piled their cartload of sticks. Marsh-grass of every imaginable shade of green covers other islands, along whose edges mud-flats begin to glisten as the tide leaves them exposed. Curlews, gulls and rails run back and forth, and probe for worms and snails.

As the afternoon passes, whiffs of salt air, fresh from the ocean, come to us, and soon we catch glimpses of sandy beaches and dunes. Twilight begins to close around us as we drop anchor in Loon Channel, just abreast of the Life-Saving Station on Cobb Island. This is the island we are to study, and we will never forget our first view of it. The western sky still glows dull red, the eastern is a mass of black storm-clouds, sending out fierce gusts which moan through the rigging as we eat our supper in the schooner's cabin. Most vivid lightning plays about us, and shows the tossing marsh-grass and swirling sand of the island near by. The staunch little boat tugs at her anchor as the black tide rushes past straight from the sea, and every now and then a curious

complaining cry comes from the darkness around the boat—a subdued yēh!—yēh! yēh!—yēh! and our guide tells us that a pair of flood-gulls are passing—following the flood-tide and feeding as they go.

Another weird nocturnal scene is vouchsafed us before the prosaic light of day lessens the mystery, but not the interest of the vague sounds and shapes of this first night. We escape the storm by sleeping in the great launching room of the station, with the wonderful self-righting and self-bailing surf-boats on either hand. About midnight the bright moonlight pours through the wide double doors and awakens us, and going out we find that a wonderful change has taken place. Perfect calm has succeeded the storm, and the great yellow moon, occasionally dimmed with fleecy clouds, makes the vast stretches of marsh only more black, with here and there a silvered bit of water. The slack tide ripples against the reeds, and from everywhere, back in the marsh, along the water, and even from under the station itself, comes a most weird and bewildering chorus—the subdued chuck! chuck! of invisible clapper rails.

Cobb Island is a link in the chain of outlying islands which threads our coast from New Jersey south to the Carolinas. It is about twenty miles north of Cape Charles, opposite Cheriton Station on the New York, Philadelphia and Norfolk Railroad. This island was at one time a fashionable summer resort of Virginians, and as early as the civil war had one or more large hotels and several private dwellings. The former owner of the island, a man named Cobb, accumulated a small fortune by making salt from sea-water, and being proprietor of this summer resort. In those days the island was about fifteen miles long and three or four miles wide, and was at a safe elevation above sea-level. Some ten years ago currents of the ocean began to undermine the island, and now it is uninhabited, its hotels and dwellings having been washed away. Reduced to about one-half its former size, Cobb Island is still one of the principal breeding-grounds of the sea-birds of our middle Atlantic coast. The trust which the white-winged creatures placed in old Ocean, depending on her for daily food, and rearing their young almost within reach of her waves, was not misplaced. With a rush and a swirl she toppled over the structures of the human intruders, drove them in terror from the island, and left but shifting sand-dunes, safe only for the sea-swallows and their kin whose cries had echoed the roar of the surf so many years before their human enemies appeared.

The island may be divided longitudinally into six zones, which

merge into one another at certain portions, but, on the whole, are fairly distinct. The seven miles of beach on Cobb Island, which faces the ocean, is a long stretch of breakers booming upon a beach of yellow sand. At certain spots windrows of oyster-shells are piled many feet high, and pebbles and shells cover the upper portions. Beyond the reach of ordinary tides the curving mounds of the sand-dunes are seen, covered with a scanty growth of coarse grass, mingled with clumps of maritime goldenrod.

Farther inland these dunes rise higher, and are composed partly of earth. Here the grass grows rank and close, and bayberry and "kings" bushes appear. This zone, in the northern portion of the island, continues to the western side, to the edge of the brackish high tides, where it is succeeded by a zone of tall reeds and marsh-grass. Farther out on the mud-flats eel-grass appears, around whose stems hordes of minnows and crabs abound, and where occasional diamond-backed terrapin may be picked up. From this point, especially at the north end of the island, the tide leaves bare a wide expanse of flats, dotted with hollows where the deadly sting-rays hide. Now and then the great side fins of one of these uncanny creatures may be seen undulating through the shallows.

Such is a brief sketch of Cobb Island, a few acres of pebbles and marsh and dunes, which, except for the Life-Saving Station near one end, is as primeval as the day the eye of man first beheld it. Utterly useless for human purposes, it is the home of hundreds of beautiful beings, who fly around us in clouds begging for the safety of their young and eggs, not an individual among them who would not risk its very life to shield its nest from harm. Last year a terrible danger threatened the birds and their young, in the shape of cats which were turned loose on the island. But old Nature came to the rescue of her children, and every feline perished in the first high tides of October. When we learn that twenty-eight hundred birds have been slaughtered in three days on Cobb Island for millinery purposes, we may well blush at having to acknowledge that there exist such brutes in human guise. The least we can do is to guarantee protection to the survivors and their eggs from now on.

To do this intelligently we must know the ways and habits of the birds. So here on the dunes of Cobb Island we pitch our tents; we patrol the beach watching the birds in calm and storm; we pry into their life at midnight, with only the faint ray of a bull's-eye lantern and the roar of the surf to guide us; we photograph them and their eggs and young; we discover their food

and enemies; and finally, when we leave them unmolested, it is with the hope that they look upon us as their friends, and we wish that they could appreciate the sympathy and affection which close companionship with such beautiful living creatures has aroused in us.

We remained five days upon Cobb Island—July 12–18 inclusive—and observed twenty-three species of birds, twelve of which were breeding, or had bred this year on the island. This list would doubtless have been longer if we had not confined our attention almost entirely to the gulls, terns and skimmers. The following is a list of these birds with a *résumé* of the notes which we made during our brief stay. One could spend a year upon this limited area without beginning to exhaust the interesting facts of its bird life.

The usual order of classification has been reversed, so that the most interesting and characteristic birds of the island are the last in the list.

1. Barn Swallow (*Hirundo erythrogastra*, Bodd). Fifteen or twenty pairs of these birds build their nests beneath the station buildings, on the ledges near the piles, the only available places for them, so their presence on Cobb Island is dependent on man. They feed chiefly on mosquitoes which they glean from the brackish marshes at the south end.

2. Song Sparrow (*Melospiza cinera melodia*, Wils.).

3. Seaside Sparrow (*Ammodramus maritimus*, Wils.).

Four or five pairs of each of these finches breed here. I found several nests and saw young birds of both species. Several song sparrows and at least one seaside sparrow were in full song. These birds keep to the zone of "kings" bushes near the center of the island and feed on both seeds and insects.

4. Meadowlark (*Sturnella magna*, Linn.). One individual heard and seen.

5. Nighthawk (*Chordeiles virginianus*, Gmel.). Several of these birds hawked about the island every evening, apparently finding a plentiful supply of insect food in the air high above the marshes. They are said to lay their eggs on the sand.

6. Osprey or Fish-Hawk (*Pandion haliaëtus carolinensis*, Gmel.). Three or four Ospreys were seen fishing near Cobb Island or flying over. They had half-grown young in their nests near by on Marchon Island.

7. Red-Tailed Hawk (*Buteo borealis*, Gmel.). A single individual of this species was seen passing over the island headed straight for the ocean. He flew steadily and took no notice of the terns which were mobbing him.

8. American Oyster-Catcher (*Hamatopus palliatus*, Temm.). Two pairs of these handsome birds were on the island during our stay. We were told that both pairs had bred on the beach in April, but we saw no signs of young birds. The long legs and straight coral-red beak serves to distinguish this species at a considerable distance. This forlorn hope of Oyster-Catchers arrives about the first of April and leaves for the South in September. With suitable protection these interesting birds should breed abundantly here, even though oysters are much less numerous than formerly. Their eggs are hatched and the young birds fledged before the gulls and terns begin to breed.

The mandibles of the Oyster-Catcher are thin, knife-like blades, and show very distinctly the rough usage to which they are subjected in opening the shells of mollusks. One side is invariably worn down, and sometimes the bill is permanently bent from the constant prying strain. I noticed these birds feeding on small sand-fleas.

9. Wilson's Plover (*Ochthodromus wilsonius*, Ord.). We found six of these dainty birds. These also were reported to have bred in April, but no young birds were on Cobb Island while we remained there. Their time of arriving and leaving is about the same as the oyster catcher, and like those birds they seem only waiting the chance to cover the sands with flocks of their black-banded scurrying little forms. Their food consists of small crustaceans and insects.

10. Long-Billed Curlew (*Numenius longirostris*, Wils.). A few individuals of this rather rare species flew past the island during our stay.

11. Hudsonian Curlew or "Jack" Curlew (*Numenius hudsonicus*, Lath.). These long-legged birds nest in Alaska and other parts of the far north, and the several small flocks which we saw on Cobb Island were the first of the great host of migrants which wing their way each year from their breeding-grounds to the marshes of South America.

12. Spotted Sandpiper (*Actitis macularia*, Linn.). Five or six Spotted Sandpipers teetered along the mud-flats near our landing, busily seeking out the worms and snails left exposed by the tide. They doubtless breed on the adjacent mainland.

13. Willet (*Symphemia semipalmata*, Gmel.). At least two pairs of Willets were breeding on the island. They were greatly concerned when we approached close to where their eggs, or probably young, were concealed. They uttered their plaintive "willy-willy" and fluttered over our heads with dangling legs, or



LAUGHING GULL ON NEST.



BLACK SKIMMER ON NEST.





swooped fearlessly toward us. Despite our painstaking search we could not discover their secret, and we hope that any enemy may have been as unsuccessful. During this season the Willets feed principally on worms and insects.

14. Solitary Sandpiper (*Helodromas solitarius*, Wils.). I noticed two specimens feeding on the mud flats. This is an early date for this bird, as it nests north of the United States.

15. Yellow-Legs (*Totanus flavipes*, Gmel.). Like the curlew, the small flocks of Yellow-Legs were the advance guard of the thousands of their kin which would soon appear from the north and pass southward.

16. Clapper Rail or Marsh Hen (*Rallus crepitans*, Gmel.). This is the most characteristic breeding bird of the marshes on and near Cobb Island. It is very wary and secretive, and seldom allows itself to be seen, but its reiterated calls combined with the remarkable ventriloquial power with which they are uttered, makes it seem as if every bunch of grass hid one or more of these birds. They are very abundant on the island, and without particular search we found several of their nests. The young birds had left in most cases, and two sets of eggs of seven and nine respectively, were almost ready to hatch. A wooden causeway built on piles connected the main building of the Life-Saving Station with the ocean side, and just about two feet to the right of this, half-way across the island, a Clapper Rail had built her nest. Several times we crept up and watched her leave her eggs—a small brown form which swiftly and silently threaded the reeds without touching the water.

On June twenty-third and twenty-fourth unusually high tides had destroyed the nests of hundreds of these birds, and their eggs were washed up along the shore in windrows. The nests which we found in the low marshes had all been built since that time and showed a remarkable provision against a repetition of such a disaster. The nests on the higher dunes were merely a rough collection of reeds upon the ground, while the nests in the flooded portions of the island, although rebuilt at almost the exact location of the old nests, were woven between supporting reeds some eighteen inches higher, the old flattened nests forming a rough platform at one side and below the new structures, and used by the rails as resting places in leaving or returning to the eggs.

The rails feed on small crabs and insects, and they certainly cannot lack for food. If anyone has ever stood barefooted in the waters of a Cobb Island marsh photographing the nest of one

of these birds, he will readily admit that voracious minnows and ravenous crabs are there in tens of thousands!

The little rails and their eggs are considered great delicacies in this part of the country, and suffer accordingly. From the causeway we had a point of vantage; but approach a ground nest, even with the utmost care, and no sign of the parent will be visible. But do not be too ready to accuse the tiny mother of undue fear or neglect, for the spotted eggs will always be warm to the touch.

17. Great Blue Heron (*Ardca herodias*, Linn.). Several young birds of the year had made Cobb Island their home, attracted by the vast quantities of fish and crabs in the marsh creeks. They probably remained there until the fall migration. These birds were hatched, doubtless, at the rookery at Cheapside, some miles away on the main shore. They were quite tame, not having as yet learned the treachery of mankind.

18. Black Skimmer, also known as Flood-Gull and Sea-Hound (*Rhynchops nigra*, Linn.). Of all the birds whose habits we studied on the coast of Virginia, the Black Skimmers were the most interesting. They breed near the gulls and terns and yet showed most distinct characteristics. Although, owing to the inartistic aspect of the head, these birds have not suffered at the hands of milliners to such an extent as the terns and gulls, yet their numbers have been greatly depleted, and we found that they have another no less terrible foe to combat. These birds are really terns, with a strangely modified bill fitted for their unique method of feeding. They are very strikingly colored, the entire upper part of the plumage being jet black and all the under parts white. The bill and feet are bright red. The upper mandible is always much shorter than the lower, and both as thin as paper knives and as pliable. The method of feeding of these birds has often been described, and yet no description is adequate,—no words can present the charm of their graceful flight. Although these birds are only about a foot and a half in length, their long, narrow wings spread fully four feet. These powerful pinions enable the Skimmers to fly very close to the water, so close indeed that the long lower mandible drops beneath the surface and ploughs a zigzag furrow. All worms and small fishes in the path of this furrow are thus scooped up into the mouth of the bird. And yet, even with such a remarkably shaped bill, it is not impossible for these birds to feed in other ways. We saw several swimming about in small pools and picking up floating insects and small crustaceans. And again a Skimmer, when getting food

for its young, will make one dash at the water and seize a small fish crosswise in its beak.

It is not until late in May that these curious birds arrive from the south and scatter to their various breeding-grounds along the coast. Whether they pair for life I do not know, but the remarkably close association of pairs during the summer, whether making the nest, incubating the eggs, or feeding, would lend credence to such a theory.

For nesting-places the birds select the upper portion of the beach, which is thickly strewn with clam and oyster shells and scattered bits of sea-weed. Here they nest in colonies, eight to ten birds sometimes laying their eggs within an area of a few square yards. A small depression is hollowed out in the sand, and, this simple preparation having been made, three or four eggs are deposited. These are very beautiful, the ground color being white, and the whole surface spotted and splashed with black and brown. They vary greatly, and one specimen was seen which was entirely white with only a single large blotch of black on the side.

One would think that such coloration would render the eggs very conspicuous, but such is not the case, and we had to use the greatest care to keep from trampling on the eggs before we saw them. When an oyster-shell happened to extend within the nest, the bird apparently made no attempt to remove it, and in no less than six instances we noticed one of the eggs resting in the hollow of a clam-shell.

We were too early to find young Skimmers, as the birds had been delayed by the destructive high tides, but the old birds were a never-ending source of interest. From the actions of certain individuals it is probable that a very few of the eggs had been hatched. The proverbial needle in a haystack is an easy task compared to finding one or two young sand-colored Skimmers among the miles of dunes, and all search which we made was in vain.

There were two scattered colonies of Skimmers on the island, probably fifty pairs of birds altogether. They were much more solicitous as regards the welfare of their eggs than were the gulls or terns. As we walked up the beach we could see the birds in the distance sitting on their nests, their black upper parts showing conspicuously against the sand,—all facing up wind. The danger line once crossed, all the birds rose as one and wheeling outward swooped past us, their scissor-like mandibles working as they uttered their anxious yěh! yěh! As we approached

the immediate localities of the nests, the excitement increased. Nearer and nearer they swooped toward us, and now one of their most interesting habits was shown. Like night-hawks, partridges and other land birds, they simulated weakness and extreme disablement. No other species in the vicinity practised this deceit, but there was no mistaking the intentions of the Skimmers. They exerted themselves to the utmost to decoy us away, and always in one direction—toward the sea. The birds swooped at us from right or left, and when close turned sharply outward and flapped slowly toward the water, keeping close to the sand. They struck forcibly with their breasts every hummock of sea-weed in their path, and their progression until they reached the edge of the breakers was a succession of bumps. When only hard damp sand was in their path they lowered their tiny red feet, and partly broke the force of the concussion. When we actually reached the eggs of the outlying nests of the colony, the owners redoubled their efforts, and it was a strange sight to see several go bounding along, occasionally rolling head over heels and lying still a moment, perhaps weakly waving one wing. When they saw that all their efforts were unavailing, the whole flock flew to the edge of the water and alighted. Here they remained until we left the vicinity of their eggs. When thus resting at a distance they looked more like little top-heavy wooden manikins, or a lot of badly made decoys, than like living birds.

We found it a very pleasant experience to leave our tents at the first hint of dawn and walk up the beach, this proving a very favorable time to study the birds, as they seemed less wary at this early hour. The weird ghost-crabs scurried away before us like silent sand-wraiths, and disappeared into their tunnels. They abounded everywhere, and it was quite startling, at first, to awaken in one's tent and see several of these little creatures, twiddling their absurd stalked eyes at the entrance of their newly dug burrow at one's bedside. If a heavy dew had fallen during the night and no wind had disturbed the sand, we could read on its surface, or on newly fallen snow, the record of every creature which had stirred. Here a worm had burrowed to the surface, crawled some distance and vanished, but the imprint of a pair of gull's feet near by explained the mysterious disappearance. Farther on we noticed a crab encircling a Skimmer's eggs with his complicated trail—a mark more sinister than we then supposed. A picture of another Skimmer's nest taken in the early morning, shows evidence of her faithfulness; her tracks to the nest, the impression of her forked tail and the deep lines where her lower



BLACK SKIMMER'S NEST AND CRAB.



BLACK SKIMMER'S NEST.



mandible rested upon and cut into the sand at the margin. These bill marks were a sure indication of the direction of the wind during the night and sometimes the entire circle would be thus indented.

Late in the afternoons of windy days we noticed that some of the eggs of the Skimmers were fairly buried beneath the shifting sand, and soon after, when the bird had cleared her eggs, we were given hints of the way these birds make their nests. Unmistakable signs, made the more permanent by the damp cohesive nature of the sand immediately beneath the surface, showed that when the bird wished to make or deepen a hollow, she stood on the edge and flicked out the sand with her flat lower mandible, or else balanced herself in the center of the depression on one leg, and kicked out the sand behind her with the other foot. Weak and small as these limbs are, a Skimmer can send lumps of sand to a considerable distance. When a good-sized depression had thus been made, the bird settled into it, and turning round and round, moulded it smooth with her breast. When they settle down upon their eggs they utter a soft lower note, very different from the yēh! yēh! which is their usual vocal utterance.

Of the two hundred or more young Skimmers which we estimated would soon be scurrying over the sand-dunes of Cobb Island, we later learned that not one lived to mature. The cause was reported to be the crabs which so amused us during our stay, but which, at the thought of their devouring every one of the poor helpless fledglings, we now think of with disgust. If this is true, as my recent experience with young Skimmers has led me to believe, a new factor enters into bird protection, comparable with the voracious gulls of the bird colonies on the Farrallone Islands off the California coast, which seize every opportunity to devour the eggs of other birds. The fish-crows of the Florida heron rookeries have also become chronic nest robbers, carrying a failing of their family to an extreme.

The problem of the crabs is one to be undertaken and solved at once if these birds are to be saved from extermination, and it is hoped that during the coming season absolute proof either of the innocence or guilt of these crustaceans can be obtained.

The local name "Flood-Gull" is given to these birds because of the habit which the Skimmers have of following the flood-tide up the creeks in search of food. They are called "Sea-Hounds" from a fancied similarity between their call and the baying of a distant foxhound while in the chase. Their strange habit of feeding at night has been mentioned.

The Black Skimmers leave for the south about the first of October, and are not again seen until the following spring. In the place of the thousands of these birds which formerly bred along our middle Atlantic coast, there are now but two or three small colonies north of Cape Charles, the largest of which are the two,



HALF-GROWN COMMON TERN.

each consisting of about one hundred birds, which breed on Assateague Island.

A flock of these birds—a mass of black, white and scarlet—flying above the green water, beyond the yellow sand, and silhouetted against the clear blue sky, is a picture which will remain in our memory for many years.

19. Least Tern (*Sterna antillarum*, Less.).—The smallest and the most graceful of the sea-swallows has become only a memory on Cobb Island, where thousands formerly made their home. Once, while at the extreme end of the island, I saw one of these feathered fairies dash past me with a frightened glance. Was



she the last survivor, haunting the place where once her young were reared?

On Assateague Island, forty miles to the north of Cobb, a colony of four hundred Least Terns still hold their own, and the last week in July about a hundred young birds were safely hatched.

20. Common Tern (*Sterna hirundo*, Linn.).—We estimated that there were about five hundred mature Common Terns and two hundred eggs on the island. These had just begun to hatch, and pipped eggs were in almost every nest. These birds begin to arrive about April first and leave in October. Next to the



GULL-BILLED TERNS IN NEST.

One is just breaking through the shell.

Least Terns they have paid the heaviest tribute to plume-hunters and the agents of milliners.

As we approached a colony of Common Terns, they rose *en masse* and circling and wheeling about our heads filled the air with their anxious cries,—tearr! tearr! tearr! But no matter how closely we examined their eggs or young they never seemed

as bold as the skimmers. Their favorite nesting site is the irregular line of sea-wrack which marks the highest reach of some unusually high tide. When they nest on the bare sand, a few stems of reeds or grass are placed around the eggs. This is, doubtless, the last remnant of some former more elaborate and useful nest-building trait.

The nestling Terns, as soon as they are dry, begin to pant from the excessive heat of the sun and leave the nest at once, scrambling along until they rest under the shade of some stalk of goldenrod. Most of the young birds spend the day squatting close to the ground, and only moving to welcome the approach of the parents with food. They are fed on predigested fish for over a week. The Terns hereabouts are called "Strikers," from the method of fishing of the old birds, which dash down vertically against the water with a momentum which sends up a cloud of spray. At night the Terns and other young beach-hatched birds take long excursions. At eleven and twelve o'clock it was most interesting to take a bull's-eye lantern and walk noiselessly along the shore, with only a narrow swath of light to guide us. Tiny white forms would occasionally scurry away, and giving chase we would soon run down a young tern. It seemed strange to find such tiny helpless little beings abroad in the darkness, but at the first frightened peep which he uttered at being cornered, a harsh angry tear-r-r-r would come from the darkness overhead, and we knew that Mother Tern's sharp eyes were watching over the little fellow, guarding him through all the blackness of night.

Although secure in their island home from all four-footed enemies, yet careful study of the lives of these young birds would doubtless reveal many tragedies.

One incident which I noticed was interesting as throwing light upon a habit peculiar to many birds—that of the parent removing the pieces of egg-shell as soon as the young bird has escaped. The skimmers, gulls and Terns all do this. I watched one baby Tern escape from his olive-hued prison, and roll wet and sprawling out upon the warm sand. The parent Tern was greatly disturbed, and swooped threateningly at my head all the time I remained. As usual, a small quantity of blood escaped from the egg membranes and more remained within the shell. Hardly had the youngster freed himself when a small ant appeared at the edge of the nest, waved its antennæ for a moment and disappeared. The word had evidently been quickly passed, and scores upon scores of these ferocious little creatures swarmed over the egg-shell and young bird. The little fellow writhed and tried to

scramble away, but his strength failed him, and as the fierce ants had already pierced his thin skin, there is little doubt as to what the ultimate result would have been. I removed the blood-stained egg, scattered the ant hordes and placed the nestling Tern some distance away. Is not the principal result gained by the removal of the blood-scented shell to lessen the danger of attacks from keen-scented enemies—insects and others,—rather than to bridge over any fancied weakening of the protective coloration scheme which the unbroken egg and the young bird so perfectly typify? And when we consider what a great source of danger the diffusion of the odor, even of the rapidly drying blood within the shell would be, does this explanation not suffice to account for this habit of ground-nesting birds, and do away with the need to trace its origin to ancestral species which carried on their nidification in trees? We were surprised to notice the extent to which the Terns and Gulls feed on insects, this diet in some cases seeming to take entirely the place of fish.

21. Forster's Tern (*Sterna forsteri*, Nutt.).

22. Gull-Billed Tern (*Gelochelidon nilotica*, Hasselq.).—About a score of these birds nest upon the island, their habits being very similar to those of the Common Terns.

23. Laughing Gull (*Larus atricilla*, Linn.).—We estimated that there were five hundred Laughing Gulls on the island, nesting among the clumps of grass in two large colonies. These were associated with the colonies of skimmers and terns, the several species evidently finding each other's presence agreeable, and thus enlivening the island at these favorite sections from the beach back through the dunes and marsh. The nests of the Gulls were in some instances very artistic, the eggs being concealed under overhanging grass stems, with an arched entrance, two feet or more in length. When the nests are built on the lower, wet portions of the marsh, they are often a foot or more above the ground, the eggs lying on a rough pile of reeds.

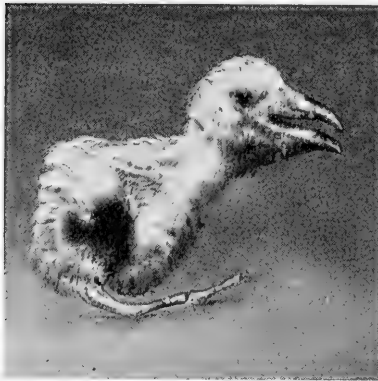
These Gulls are strikingly colored, their wings and back being pearl-gray, the large flight feathers black, the under parts white, while the head and throat is a dark slate in hue. Mr. Chapman has very aptly compared them, when sitting on their nests, to white flowers scattered over the marsh, and even when we know that they are birds, the odd coloring of the head and wing feathers, rendering these parts almost invisible, so breaks up the shape of the sitting bird that the general effect is only of an indeterminate mass of white.

The Laughing Gulls do not swoop at one as do the terns and

skimmers, but when the colony is disturbed the birds all fly back and forth—a great intermingling mass of forms in the air above the marsh. They have a clear, high note, and occasionally they break out into an ah-ah-ah-ah-ah which bears some resemblance to our expression of mirth. The young birds seem to have much the same habits as the terns, although very few had hatched at the time of our visit. At night they roam about the beach, the members of each brood keeping together. The adult Gulls, and indeed most of the birds on the island, seemed to enjoy an insect diet. Dragon flies in the marshes, and the white-winged tiger beetles of the beaches, were devoured by the hundred.

#### RESULTS.

A. As immediate direct results of the trip, ninety-two specimens of living birds, representing six species, were added to the Society's collection. Acknowledgment should here be made of the courtesy of Dr. J. W. Bowdoin, President of the Eastern



SKIMMER 14 DAYS OLD.



LEAST TERN 21 DAYS OLD.

The young birds were hatched in a Park incubator.

Shore Game Protective Association of Virginia, in granting permits to collect and to ship out of the State, birds protected by law.

B. Exhaustive notes were made upon the heron rookeries of this part of Virginia, which will form the subject of a future paper.

C. Even the brief examination which we were enabled to make



SEA-BIRDS' EGGS IN THE INCUBATOR.



YOUNG TERNS JUST HATCHED.

of the status of the avifauna of Cobb Island, showed the diminution in numbers from the figures given by Mr. Chapman and other observers in 1902 and in former years. This emphasized the importance which absolute protection would mean, not only to the breeding birds in summer, but also to the great numbers of birds which make these waters their home during fall and winter.\*

D. The most important result of our visit to Cobb Island was a discovery of far-reaching importance to the bird collections of the Zoological Society. A score or more of the eggs of terns, skimmers and gulls, nearly ready to hatch, were collected and brought to the Zoological Park, with the intention of preserving the embryos for future microscopical and gross study. When the time came to remove them, although the eggs had been gathered over three days previously, and indeed some were partly crushed on the journey, yet the little unhatched creatures were found to be in such vigorous condition that instead of being sacrificed to the science of embryology, the eggs were placed in an incubator. Not only did the individuals of each species hatch and escape from the shells, but they were successfully *fed* and *reared* by hand until the young birds were able to feed themselves. This unique undertaking has yielded many interesting facts as to the growth and development—both physical and mental—of these little-studied young birds. These notes will be elaborated during the coming year, and will fill out many important gaps in the life-histories of the birds. For example, the characteristic call and alarm notes of the adult terns and skimmers are uttered by the young birds while their bodies are yet within the egg. The food of the terns for more than a week is fish which has been macerated in the crop of the parent for about two hours, while the young skimmers require small living fish from the first. The nestlings of the black skimmer have only about one-half the strength of young common terns, and about one-third that of nestling gulls, the comparison, of course, being between birds of the same age. This would seem to lend credence to the report that the young skimmers hatched on Cobb Island this season have succumbed to the attacks of the ghost-crabs.

The fact that birds so small and so fastidious as to diet were successfully reared, presages important results when the eggs of birds of other orders can be collected and incubated. Young birds

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\* As an appendix to this article I have added a list of some of the more striking birds which other observers have noticed on or near Cobb Island, taken mostly from Dr. Rives' "Catalogue of the Birds of the Virginias."

thus hatched and reared within the confines of Bird Valley would be perfect as to plumage, tame, and absolutely contented with their life in our great Zoological Park.

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BIRDS OBSERVED  
ON OR NEAR COBB ISLAND, VIRGINIA.

Horned Grebe.	Louisiana Heron.
Loon.	Green Heron.
Red-Throated Loon.	Black-Crowned Night Heron.
Razor-Billed Auk.	Yellow-Crowned Night Heron.
Herring Gull.	Sora Rail.
Ring-Billed Gull.	Florida Gallinule.
Bonaparte Gull.	American Coot.
Caspian Tern.	Northern Phalarope.
Royal Tern ("Gannet").	Knot.
Roseate Tern.	Pectoral Sandpiper.
Black Tern.	Least Sandpiper.
Gannet.	Red-Backed Sandpiper.
Double-Crested Cormorant.	Semipalmated Sandpiper.
Brown Pelican.	Sanderling.
Red-Breasted Merganser.	Hudsonian Godwit.
Mallard Duck.	Greater Yellow-Legs.
Black Duck.	Bartramian Sandpiper.
Baldpate.	Eskimo Curlew.
Green-Winged Teal.	Black-Bellied Plover.
Blue-Winged Teal.	American Golden Plover.
Shoveller Duck.	Semipalmated Plover.
Pintail.	Piping Plover.
Red Head.	Turnstone.
Canvasback Duck.	Marsh Hawk.
Scaup Duck.	Bald Eagle.
Lesser Scaup Duck.	Duck Hawk.
Golden-Eye Duck.	Pigeon Hawk.
Buffle-Head Duck.	Barn Owl.
Long-Tail Duck.	Short-Eared Owl.
King Eider Duck.	Saw-Whet Owl.
American Scoter.	Snowy Owl.
White-Winged Scoter.	Chuck-Will's-Widow.
Surf Scoter.	Scissor-Tail Flycatcher.
Ruddy Duck.	Horned Lark.
Snow Goose.	American Raven.
Canada Goose.	Fish Crow
Hutchins' Goose.	Boat-Tailed Grackle.
Brant Goose.	Snow Bunting.
Black Brant Goose.	Ipswich Sparrow.
Whistling Swan.	Savanna Sparrow.
American Bittern.	Sharp-Tailed Finch.
Least Bittern.	Prothonotary Warbler.
Snowy Heron.	Connecticut Warbler.

# THE ORIGIN AND RELATIONSHIP OF THE LARGE MAMMALS OF NORTH AMERICA.

*By* MADISON GRANT,

SECRETARY OF THE NEW YORK ZOOLOGICAL SOCIETY.

THE increase of knowledge of the true relationship of mammals, and their geographical distribution, has now reached a point where it is possible to analyze the mammalian fauna of North America, and to indicate the continent where the original expansion and radiation of the various groups took place. Paleontology has, of recent years, shed a flood of light upon this subject, and offers, in many instances, definite proof of what has heretofore been largely conjecture.

It is the purpose of this article to briefly review the living large mammals of the United States and Canada, and to endeavor to trace their past history.

The higher fauna of North America, when compared with that of other large continents, presents an astonishing poverty as to the number both of genera and of species, and the latter are, in the great majority of cases, very closely allied to Old World forms.

The animals which the first settlers found along the Atlantic coast seemed almost identical with those they had left behind in England or on the adjoining continent. This resemblance was very close in the North, but in the South a larger number of unfamiliar forms were found. As the seventeenth and eighteenth centuries were not ages of scientific accuracy in matters zoological, names were applied at random, just as was done by the Dutch settlers in South Africa, with the result that many a misfit occurred, and the same animal bore distinct names in different sections of the country.



Along with this close resemblance, there seemed at first to be also an appreciable inferiority in the size and beauty of the animals found in America, as compared with their Old World congeners. The puma and the jaguar were compared with the lion and tiger, somewhat to the discredit of the former, and our black bear, which was surprisingly numerous in Colonial times, suffered also when compared with the brown bear of Europe; as did our Virginia deer in comparison with the European red deer.

Later, however, when the frontier was pushed inland, and the grizzly, the wapiti and the moose were measured by the standards of the European brown bear, red deer and elk, no such superiority could be claimed for the Old World animals. In profusion of distinct types, however, North America, with its bison and prong-horn, which, with the black-tailed deer and the wapiti, virtually monopolized the great prairies and plains of the West, could not vie with the magnificently diversified fauna of Africa, with its hundred and more species of bovine antelopes, to say nothing of other huge mammals.

Close as is the relationship of Eurasian and North American mammals, it never amounts to specific identity in the view of the best American systematists, who differ in this respect from European zoologists. The polar bear and one or two smaller arctic mammals form the sole exceptions to the above statement.

#### FIRST RADIATION.

This poverty of animal life, both as to variety and number, has not always existed, and a close study of the fossil mammals of North America, of which we have a very complete record from the Rocky Mountain region, demonstrates that there have been two separate and distinct periods of great development and radiation of mammals on this continent, together with several clearly distinguishable immigrations from other lands. The last of these immigrations from the Old World, by way of Behring Straits, gave us the predominant members of our present fauna.

The first of these periods of development is known as the Puerco, and dates from the very dawn of the Basal Eocene, some three million years ago. Deposits of this horizon are found in New Mexico, and have revealed to us a large and varied fauna, with true mammals, some as large as a Newfoundland dog. In European beds of a corresponding age, the Cernaysien, a similar but more limited fauna is found.

This Puerco fauna flourished and radiated, paralleling many

of the existing orders of mammals, and giving rise to primitive Carnivores known as Creodonts, primitive Ungulates known as *Amblypoda* and *Condylarthra*, and still other orders not so easily defined. Only partial traces of types which were ancestral to the Puerco fauna are found in the underlying Laramie beds, which are assigned to the top of the Cretaceous period. This would probably indicate that the Puerco mammals, to a large extent, come in from some other country, probably from the North.

#### SECOND RADIATION.

By the Middle Eocene, the early and generalized types of this Puerco fauna were rapidly dying out, leaving only a few carnivorous forms to linger on into the Oligocene. We do not, of course, know the causes of their disappearance, but it is safe to hazard the conjecture that their structural development, especially their limited brain capacity, was inadequate to cope with that of the new and more highly organized animals which suddenly appear in the Lower Eocene. These new types were possibly descended from some side line of the earlier radiation, and were derived from members of the Puerco group, which had lingered on in the original northern home, but no direct lines connecting these two faunæ are known.

Assuming that the Puerco mammals were driven out of more northerly or boreal lands, where they had originally developed, by a declining temperature, it is conceivable that some animals remained behind and adjusted themselves to the changed conditions, until a still further increase of cold forced them also to follow the path of their predecessors, southward.

Some of these Lower Eocene types of this second radiation, which are found in the Wasatch beds of Wyoming, have sent down lines of descendants, which have ultimately culminated in existing animals. At this time first appear the horses, tapirs, rhinoceroses, camels and dogs. Some of these animals, such as the horses and rhinoceroses, are found contemporaneously in Europe; others, like the camels, are peculiar to this country.

Being more highly organized and better adapted to their environment, these new types entirely supplanted the older fauna, and by the Oligocene this transformation was complete, and the older fauna had disappeared. This Wasatch fauna culminated in the Miocene, and then faded gradually away on this continent, until in the Middle Pleistocene they were largely supplanted by new arrivals from Eurasia.

Similar radiations, on as large a scale, have taken place in early Eocene times among the marsupials in Australia, and somewhat later in South America, which was then, and long afterwards, separated from North America, although probably for a shorter period connected with Africa and Australia, by way of Antarctica. In Australia the rapid replacement of the native Marsupials by the better equipped placental mammals, when the latter were introduced by man, is analogous to the manner in which the Puerco fauna was supplanted by the Wasatch fauna, through inability to successfully compete with those more highly organized types.

#### DECLINE OF ANCIENT GROUPS.

After attaining a high degree of development this second or Wasatch fauna also declined, and one of the causes which contributed to its disappearance was the gradual elevation of the Western half of North America and the draining of the ancient lake basins there, with consequent loss of moisture.

Desert lands, however, are not necessarily unfavorable to the development of structural variety and great bulk in animals. On the contrary, arid conditions seem to favor the development of large-hoofed animals, by imposing upon them the necessity of traveling over great stretches of country to find water during a drought. South Africa is a country of open plains, scantily supplied with water, many large areas being quite desert, and yet no other region of the earth can show such profusion of large mammals.

As speed and endurance are to some extent correlated with bulk, no animal of small size could long survive competition with the faster and more enduring members of its own or a rival race. Increased size leads to an accelerated development, until a limit is imposed by the question of food supply. The larger the animal the more food it requires in proportion to its bulk, hence the larger animals must spend most of their time feeding, and if, through climatic changes, food becomes scarce, or enemies appear which they cannot resist, the larger animals are the first to succumb.

A race, therefore, tends to increase in size until a maximum is reached, and is then apt to become suddenly extinct. The rhinoceroses, elephants and horses are now on the verge of extinction, all their smaller relatives having been weeded out by competition.

## AFRICAN FAUNA.

In this connection, the origin of the South African animals may be briefly referred to. Madagascar has a peculiar fauna resulting from long isolation, but the ancestral types came from Africa, where, in later times, most of these particular animals have died out.

It had long been supposed that the lemurs, the pangolins, the aardvarks, and some other types, were the only remnants of this original fauna, and that the typical large mammals of Africa originated in Eurasia, and were driven south into Africa by the advance of the glaciers in comparatively recent times. Recent investigations, however, have demonstrated the fallacy of this view, and at present the best authorities concur in viewing Africa, south of the Sahara, or the Ethiopian region, as having experienced a radiation of large mammals, quite peculiar to itself, but which took place after the separation of Madagascar.\*

That the elephants originated in Africa has been demonstrated by the recent discovery in Egypt of fossil forms, clearly ancestral to the modern Proboscideans. The Sirenia, the hyrax, the hippopotamus, and related swine, the giraffe, and the wonderful group of bovine antelopes in all probability attained their development in Africa, and possibly all of the *Bovidae* originated there also. In Pliocene and Lower Pleistocene times many of these forms pushed north, in some cases as far as England, there becoming extinct or retreating into Africa again upon the advance of the glaciers, but leaving behind in Europe and Asia some of their members, which successfully adjusted themselves to temperate or subarctic conditions.

## PREGLACIAL FAUNA OF AMERICA.

During these same periods before the approach of the glaciers a magnificent fauna flourished in North America, consisting of camels, horses, ground sloths, elephants, mastodons, sabre-toothed tigers, and others, including distinct forest and plains faunae, but few of these animals seem to have survived the great glaciers. One of the survivors was the mastodon, which, origi-

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\* This hypothesis was first fully set forth by Prof. Henry Fairfield Osborn, before the New York Academy of Science in 1900, and has been more than confirmed by the explorations of the Egyptian Geological Survey, published by Andrews & Beadnell.

nating in Africa, spread over the world, and even reached the southern end of South America in Pliocene times.

Other animals of this early period have probably survived, but we are without such knowledge of the forest fauna of preglacial and postglacial times as would enable us to trace them down to existing forms. Our American deer, *Odocoileus*, the pronghorn, peccaries and raccoons, probably are survivors of this same fauna. But the fact remains that the great majority of the early American mammals perished, probably because of their inability to cross the Mexican deserts, and because of the destruction of their normal food supply.

#### EURASIATIC CONNECTION.

During and after the glaciers came a new fauna, the immediate ancestors of the predominating types of to-day. At intervals throughout Tertiary times there apparently existed a broad land connection with Eurasia, over the present site of Behring Sea. This connection probably existed in the Lower Eocene, Lower Oligocene, Middle Miocene, Upper Pliocene, and Lower Pleistocene, and was interrupted in Middle and Upper Eocene, Upper Oligocene and Lower Miocene times.

We have several corresponding invasions from Eurasia. The first of these invasions was in the Lower Eocene; the second in the Lower Oligocene; the third, bringing in the Proboscidiæ, in the Miocene; the fourth occurred during the Lower and Middle Pleistocene, bringing the ancestors of most of the typical American animals of to-day.

This Eurasian land connection had a sufficiently temperate climate during early Tertiary times to admit of the interchange of animals which required either an unbroken forest or a temperate climate, and consequently the faunæ of the eastern and western continents were very closely related, but as time went on they became more distinct, until it is evident that some obstacle existed, probably the increasing cold temperature of the ever-narrowing land bridge. Animals which could sustain great cold and long journeys still crossed, but the more southern types were cut off.

#### THE BOREAL THEORY.

In this connection it is necessary to mention the recently advanced theory of the boreal origin of mammals, indeed of all life, both animal and vegetable. The chief evidence, so far as it

relates to mammals, adduced by the advocates of this theory, lies in the singular and simultaneous appearance in Europe and in America of the same types of animals, the hypothesis being that these animals came from a common boreal home.

As will appear below in the detailed consideration of our various animals, the place of origin of each group, based on positive and not on negative evidence, can be found in practically all cases. There can be no serious doubt, for instance, that the bear originated and developed in Eurasia. The same is true of the cats comprising the type genus *Felis*, and of the great deer genus *Cervus*.

In fact the only American animals about the origin of which there is much doubt, are the moose and the caribou. These two undoubtedly originated and attained their development in some far northern land. It is not necessary, however, to assume a polar continent for these two genera, as the existing land areas to the north of the American continent, or that portion of Siberia lying within the Arctic Circle with the recently submerged and adjacent coast, would supply boreal land areas quite sufficient in extent for the development of these types.

#### TYPE DIVERGENCE.

In carefully considering the various types of North American mammals a very important clew to their origin can be found in the degree of differentiation which each one of these animals has achieved. It would appear that this degree of radiation and of departure in structure from their Old World kindred would in some measure correspond to the amount of time which has elapsed since the first appearance of these animals in North America. The deductions in this article are based on these lines of reasoning, and the conclusions are in most instances confirmed by the fossil record.

When we find, as in the case of the genus *Cervus*, of which our sole American representative is the wapiti, that the Old World has about twenty species belonging to this genus and to closely allied genera; that is, one species as an inhabitant of the New World, against about twenty in the Old World (and some of these Old World species, like the Altai wapiti from Mongolia, are very closely akin to the American wapiti); when we can go from England eastward through Germany, Hungary, the Caucasus and the mountains of Central Asia, and find the red deer growing larger and finer, and fading imperceptibly through one

species after another into this Altai deer, which is in turn almost indistinguishable from our great American wapiti, how can we escape the conclusion that the centre of radiation of the genus *Cervus* was in Eurasia, and our wapiti so recent an immigrant from the Old World that it has not had the time to evolve, under the varied influences of its new habitat, well-marked species, there being at most only two or three races of subspecific value.

Turning to the fossil record we find that no member of this genus has been found in America of an earlier age than the Middle Pleistocene.

A similar line of reasoning applied in turn to each of the large American animals, enables us to draw what appear to be accurate conclusions not only as to their original home, but as to the relative duration of the type in America.

Not all our animals, however, came from the Old World, although the predominating types undoubtedly did. South America contributed a few types, and others, like the raccoon, peccary, prong-horn and American deer, are either autochthonous, or else have been here so long that their specialization has taken place entirely on this continent.

To take up the possible places of origin of our living mammals in the inverse order of their importance, we find them to be: a migration by a possible land bridge over the Atlantic; migration from South America; development in North America, and last, and by far the most important, migration from Eurasia by way of Behring Sea.

#### ATLANTIC BRIDGE.

A mid-Atlantic land connection has been suggested, but has little evidence in its favor, and can be practically disregarded, and, while there is no doubt that continuous land connected Greenland, Spitzbergen and Scandinavia in Pleistocene times, no known element of our fauna was derived from this source.

#### SOUTH AMERICA.

South America was entirely separated from North America until the Pliocene, but apparently since that period has been more or less continuously united to North America. The southern continent, during this long period of isolation, before the Pliocene, developed several groups of large and clumsy animals which almost defy classification, but which stand close to the Ungulates,

and for the reception of which several new orders have been created.

During the Lower Pliocene the mastodons entered South America, and the Edentates, represented by the extinct ground sloths and the living armadillos, found their way into North America, together with a number of hystricomorph, or porcupine-like Rodents, which have since spread throughout the world.

In the Upper Pliocene a more extensive interchange of animals took place, South America receiving from the North its camel-like llamas, its cats, its dogs, its raccoons, its numerous deer, and many others. The peccaries did not reach South America until the Pleistocene.

The cats, represented by the sabre-toothed tigers, entering the southern continent at this time (Upper Pliocene) very possibly played a large part in the destruction of the giant herbivores, which flourished at that time on the Pampas. It would almost seem that the sabre-toothed tigers were modified in their marvellous dentition for the express purpose of preying on these huge and thick-skinned animals.

South America at this time received its deer, all of which are closely related to *Odocoileus*, but which have been there long enough to evolve nearly twenty distinct species.

The horses, too, entered South America during this period, and survived there nearly until the arrival of Europeans.

Of the animals which North America received from the southern continent during the Pliocene, few have seemingly survived, except the porcupines and armadillos. The opossum did not come from South America, but is a survivor of a family of early Marsupials, *Didelphidae*, which were once widely spread throughout the northern hemisphere, but which have become extinct in the Old World.

#### NORTH AMERICA.

We have in America one family of the Carnivores, *Procyonidae*, and two distinct families of hoofed animals, *Dicotylidae* and *Antilocapridae*, and one very important genus of the deer family, *Odocoileus*, none of which have close relatives in the Old World. All these four groups are probably of autochthonous origin, and their peculiar characters are described at length below.

#### EURASIA.

The remaining large North American mammals, the wapiti, the bison, the musk-ox, the mountain sheep, the mountain goat,



many cats, including the lynxes, the bears, the otter, the wolverine, the fisher, the marten, the mink and the beaver, are all more or less recent immigrants from Eurasia. The moose and caribou also probably came from the extreme north of the same continent.

It is from the character of the animals above named, which are nearly all of northern or subarctic habit, that we draw the inference that this land connection between the continents lay far to the north. From their close relationship to Eurasian animals we can also infer that the connection persisted until very recent times. Let us now examine the chief groups of the large American mammals one by one, and see what knowledge can be gained from a study of the distribution of the members of each genus, and of closely allied genera.

## CARNIVORES.

### BEARS.

Taking up the *Ursidae* first of all, we find that all of the American bears belong to the type genus *Ursus*, although there are several ill-defined subgenera.

Like the deer, the bears are essentially northern animals, and are widely distributed throughout Eurasia, with a single outlying species in North Africa. Their absence from the Ethiopian region, or Africa south of the Sahara, is probably due to their inability to pass the barrier of the deserts.

If we take the common European brown bear, *U. arctos*, and follow, by way of the great mountain ranges, its gradually increasing racial variations across Europe and Asiatic Russia, we find one type fading into another, until in the hairy-eared bear of Amurland, *U. piscator*, and the great Kamchatkan fish bear, *U. behringiana*, on the easternmost confines of the Old World, we have bears very close in type and structure to the brown bears of Alaska on the American side of the straits. The similarity would probably prove even more striking than we now believe, if we had more accurate data about this great fish bear, which, until the discovery of the Kodiak bear, was the largest known carnivore.

Neither of these bears is inferior in size to the Pleistocene cave bear, *U. spelaeus*, or its American congener, *Arctotherium*.

More distantly related to these Eurasian bears are the grizzlies, and most distant of all are the black bears. Leaving out of con-

sideration the white bear, which is circumpolar in its distribution, and is assigned to a separate subgenus, *Thalarctos*, we can place all the American bears in one of these three groups.

#### THE BLACK BEAR GROUP.

Judging from the degree of type divergence and from distribution, the first of these bears to arrive in North America was the black bear group, *U. americanus*. Its variation from the true *Ursus* is of subgeneric value, and the members of the group are assigned to the subgenus *Euarctos*. This group we find distributed throughout the length and breadth of North America to the limit of tree growth in the North and West, with a subspecies, *U. sornborgeri*, in Labrador, and species in Florida, *U. floridanus*, in Louisiana, *U. luteolus*, a recently described bear of large size from Queen Charlotte Island, *U. carlottae*, and most distinct of all, the blue or glacier bear, *U. emmonsii*, with a limited distribution in Alaska, in the district of the St. Elias Alps, and eastward among the rugged coast ranges as far as Juneau.

In South America a closely related form, the spectacled bear, *U. ornatus*, has followed the Peruvian Andes south of the equator. It is sometimes assigned to a subgenus, *Termarctos*, but is very closely related to the typical black bear, *U. americanus*.

As the black bear only extends into Mexico there is a long break in the distribution of the genus, where bears have apparently died out. So that we need not be surprised to find that this isolated South American form is somewhat aberrant. This bear is, furthermore, the sole representative of the family in the southern hemisphere.

It is quite evident from the distribution of the group that its residence in America is of considerable antiquity.

#### THE GRIZZLY GROUP.

All these black bears differ from the European bears more than do the grizzlies. From this fact, and from the distribution of the grizzlies along the range of the Rockies, we can safely believe that they are later arrivals from Eurasia than are the black bears.

The grizzlies have not evolved any well-marked species except perhaps the Barren Ground grizzly of the far North, *U. richardsoni*, about which very little is known.

The type species, *U. horribilis*, is distributed throughout the Rockies from Alaska to Mexico, with two subspecies, the Alaskan grizzly, *U. alascensis*, described from Norton Sound, the existence of which is still in dispute, and the great California grizzly, *U. horriaeus*.

#### THE BROWN BEAR GROUP.

The third and, judged by the same tests, the latest group to arrive was that of the Alaskan brown bears. Its members have departed but little from the Eurasian bears, and a comparison of forms may bring the resemblance still closer.

These bears have known a distribution along the South Alaska coast as far as the mountains at the head of Portland Canal, and extend probably far inland toward the north. While the group has split up into a number of races, the gradations are scarcely distinguishable, and it is probable that the further examination of specimens from intermediate points will result in the merging of some of the species.

The American type of the brown bear is the great Kodiak bear, *U. middendorffi*, from Kodiak and adjoining islands. It is the largest of all living carnivores, and is closely related to the mainland bear along the adjoining coast.

These mainland bears have been assigned to a number of species or subspecies, beginning on the west in the Alaskan peninsula: *U. merriami* or *U. gyas*; farther to the east, *U. kidderi* of Cook Inlet, *U. dalli* of Yakutat Bay, and *U. sitkensis*, which appears to be the most eastern of the group.

Turning now to the fossil record, we find no fossil bear in North America until the Pleistocene, whereas bear abounded in Europe in the Lower Pliocene. A related form, known as *Arctotherium*, entered South America during the Pleistocene, but undoubtedly came from the north, as it has also been found in the Pleistocene cave deposits of California.

#### MUSTELINES OR WEASELS.

Of the American members of the *Mustelidae* there are but three genera which are peculiar to America. First, the American badger, *Taxidea*, which dates back at least as far as the Pleistocene; and the skunks, *Mephitis* and *Spilogale*, neither of which have Eurasian equivalents nor American ancestors. Paleontology gives us but little light on these three genera.

The Family *Mustelidae* is cosmopolitan from the Middle Eocene, and, as its members have always been numerous in America, we should expect to find other equally distinct forms here, but, as a matter of fact, we are indebted to Eurasia for most of the well-known forms, the otter, the wolverine, the fisher, the marten, the mink and the weasel.

#### RACCOONS.

The Old World family of civets, *Viverridae*, is entirely unknown in America, and its place is taken, on this continent, by the peculiar family of the raccoons, *Procyonidae*, which are of North American extraction, and have no relatives in the Old World.\* The line of ancestry of the raccoons leads back on this continent in a series, of which we have the most important links, to certain primitive *Canidae* of the Oligocene.

The *Bassariscus*, one of the most interesting of the raccoons, is probably an almost unaltered survivor of one of these primitive forms.

#### THE WOLVES AND FOXES.

The *Canidae*, like the *Mustelidae*, swarm in North America from the Oligocene down, and in fact are cosmopolitan. The evidence of the direct descent of the more typical forms is inconclusive, but the species of the Upper Miocene, in North America, are in general more nearly related to living South American and certain Old World types than our present wolves and foxes. This is as it should be, and is another evidence of the migration of the old types southward, and their replacement in North America by later immigrants.

The Virginia gray fox, *Urocyon*, forms the only distinctly American genus of this family, and is possibly a survivor of the preglacial fauna. Our other wolves, *Canis*, and foxes, *Vulpes*, are close relatives of Eurasian forms.

#### THE FELINES OR CATS.

The remaining family of the Carnivores, the *Felidae*, is also well-nigh cosmopolitan in distribution, and the species that form

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\* *Panda* is to be referred to the bears rather than to the raccoons.

the type genus *Felis* are nearly all closely related, and vary in size and color rather than in structure.

The sabre-toothed tigers were in North America in the Pliocene, and entered South America in numbers at that time. Recent discoveries indicate an American line of sabre-tooths back to the Lower Oligocene and perhaps earlier, and one genus, *Smilodon*, existed until comparatively recent times, even as late as the Middle Pleistocene.

The type genus, *Felis*, occurs doubtfully in the Upper Miocene, and certainly in the Pleistocene, but this genus undoubtedly achieved its development in Asia, and thence spread throughout the world.

To the puma is probably to be assigned a rather more recent development, as, while it ranges from Canada to Patagonia, the local races which have arisen are all of doubtful value. Closely related fossil forms, however, suggest a possible American origin of great antiquity on this continent.

In America, the genus *Lynx*, which is a thoroughly northern, possibly boreal, type, contains three well-marked species, *L. canadensis*, *L. rufus*, *L. baileyi*, the last a western form, together with ten or more subspecies. All are closely related to European forms.

#### RODENTS.

Of the great order of Rodents, two interesting families are confined to North America. The curious sewellel, or mountain beaver, *Haplodon*, is surely of American origin. It has no near relatives outside of North America, and can probably be traced back, through Lower Miocene forms, as far as the Oligocene. The *Geomyidae* or pouched rats are also peculiar to America. Of the true *Muridae*, the genus *Fiber*, the muskrat, goes back to the Lower Pleistocene. Since it is closely related to the voles, *Arvicola*, it also is probably of Eurasian origin.

As has been already mentioned, the porcupines represent a peculiar group of South American rodents, which has now attained a world-wide distribution, and is interesting as the sole contribution of South America to the fauna of Eurasia and Africa. The genus *Erithizon* may have been developed in North America, but the ancestral type unquestionably came from the south.

## THE UNGULATES.

The next great group to be considered is the order of Ungulates.

## PECCARIES.

Like the American deer and prong-horn, the peccaries form a peculiar American family, *Dicotylidae*, and are the American equivalents of the Old World swine, to which they are not closely related. They entered South America in the Pleistocene, but existed in North America throughout the Pliocene, Miocene and back into the Oligocene, and their North American ancestry has been clearly traced.

## BOVINES.

## BISON.

The next family of the Ungulates is the *Bovidae*, and its largest American member is the bison, *Bison americanus*, which is very closely related to the European bison or wisent, *B. bonassus*, now often miscalled the aurochs.

The American bison is probably a relatively recent immigrant from the Old World. It does not occur in the Lower Pleistocene *Equus* fauna, but comes in abundantly just above. Several other species of fossil bison go back to about the Middle Pleistocene, one, *B. priscus*, being found fossil both in Europe and in Alaska. These bison probably represent other species which arrived at the same time, rather than the ancestral stock of the living animal.

Additional proof of its recent arrival is indicated by the fact that while attaining the greatest numerical development of any American hoofed animal, and with an immense range, extending from Great Slave Lake to Mexico, from the Rockies to the Atlantic tidewater, and northeastward into New York State, it appears to have developed but one imperfectly marked subspecies in the far North, known as the wood buffalo, *B. americanus athabascae*.

## MUSK-OX.

The bovine nearest to the bison, in point of size, is the musk-ox, *Ovibos moschatus*, which is now entirely confined to the Bar-

ren Grounds, south and east of Cape Bathurst, and the great arctic islands to the north of the continent, including Greenland, where the local race has been described under the name of *O. wardi*.

For some reason probably connected with the food supply, it has disappeared from Alaska, and it is only recently extinct in the Old World. The musk-ox probably came into America about the same time as the bison, in fact all the *Bovidae* probably arrived about the Middle Pleistocene, at the same time as *Cervus*. In the recently discovered cave fauna of Arkansas a large species of musk-ox has been found.

#### MOUNTAIN SHEEP.

With the mountain sheep we have a case very similar to that of the bears and the wapiti. The genus *Ovis* ranges throughout Eurasia, and, like *Ursus* and *Cervus*, has one outlying species in North Africa.

In Asia it extends eastward to Kamchatka, having, apparently, its distributional centre in the central Asiatic plateau, where it culminates in the great Marco Polo sheep, *O. poli*, whose horns have a sweeping open spiral, and which is one of the most highly prized trophies that can fall to a sportsman's rifle.

The Eurasian sheep nearest in habitat and structure to the American form is the Kamchatkan sheep, *O. nivicola*, and the closely related *O. sirensis* of Mongolia. The great *Ovis ammon* is also close. In fact, nearly all the Eurasiatic members of the genus are very closely related to each other, and to the American forms.

These latter, while obviously of Eurasian origin, have been here long enough to split up into three good species and four subspecies, chiefly characterized by their coloration, but in some cases by their horn development.

Beginning at the northwest, the Alaskan white sheep, *O. dalli*, ranges throughout Alaska and the adjoining Rockies. The distribution of the closely related Fannin sheep, *O. fannini*, which is a white sheep with dark saddle-patch and other dark markings, is much more limited, and appears to be surrounded by the distributional area of *O. dalli*. Its value as a full species remains to be determined. Both these sheep resemble the type big-horn of the Rockies in the relatively close spiral of the horns, but do not grow so large in bulk.

To the south of these two sheep and in the Cassiar Mountains of British Columbia, thus interposed between it and the true Rocky Mountain big-horn, is the Stone sheep, *O. stonei*, which is very dark in color, and the horns of which have a decidedly open spiral, suggestive of the wide sweep of the horns of *O. poli*.

Small dark sheep, with horns of an open spiral, extend along the Selkirks in British Columbia to the American border, while the sheep of the main Rockies in the same latitude are clearly of the type species and have an extremely close spiral.

South of the Stone sheep, ranging from British Columbia into Mexico, is the true Rocky Mountain big-horn, *O. cervina*, with three subspecies; first, a salmon-colored race in Southern California, *O. nelsoni*; second, an outlying form in Old Mexico, *O. mexicanus*; and third, in the Bad Lands of the upper Missouri River, *O. auduboni*.

#### ROCKY MOUNTAIN GOAT.

The only remaining member of the *Bovidae* to be considered is the Rocky Mountain goat, *Oreamnos*, consisting of two species, *O. montanus*, extending from the northern Rockies of the United States into Alaska, where it is replaced near the western limit of its range by an allied species, *O. kennedyi*, the horns of which are lyrate and relatively wide spreading. The British Columbian mountain goat is a much larger and finer animal than the type species in the United States, and has recently been assigned a subspecific rank, as has the smaller form in the mountains of Idaho.

We would expect to find more species of this animal, as it is a very aberrant form of the mountain antelopes or *Rupicaprinae*, a subfamily of the *Bovidae*, of which the chamois is the best known member. While not in any sense goats, the members of this genus are to some extent intermediate between the true or bovine antelopes and the goats.

The genus most closely allied to *Oreamnos* is *Nemorhaedus*, the members of which inhabit the central Asiatic plateau, where they are known to sportsmen as the goral. An outlying form in Japan, *N. crispus*, is well known as the serow.

This strange and interesting inhabitant of the Rocky Mountains is assigned to a peculiar genus, sharing its characters with no Old World species, and, while its lineage cannot be traced farther back on this continent than the Upper Pleistocene, still



its closest Eurasian relatives are farther removed than are those of the other American genera of the *Bovidae*. In other words, the gulf between *Oreamnos* and the nearest Eurasian form is of generic instead of specific dimensions.

In discussing the antiquity of *Oreamnos*, it must be borne in mind that it may well be, and probably is, as recent an immigrant as the other three genera of the *Bovidae*. A closely allied species may have existed in Siberia until very recently. Once extinct, and with no known fossil remains, we should have no trace of its existence. In the case of the musk-ox, the Eurasian and Alaskan forms died out, but their fossil remains were found and demonstrated the former existence of the genus in those countries.

As to the fossil record of the *Bovidae* in general, no sheep, goats, antelope or true oxen have been found fossil in America. In fact goats, antelopes, and true oxen never existed on this continent, and no bovines of any sort appear until the Middle Pleistocene, so that all the American genera of the *Bovidae* are beyond dispute of Eurasian origin.

Comparing these four outlying groups with the wonderful development which the members of this family attain in the Old World, we cannot help regretting, either that the American representatives have not been here longer, and evolved more distinct and striking types, or else that nature had, in the first instance, been more lavish in the number of species which crossed the Behring Sea land bridge.

Considering the Family *Bovidae* as a whole, we find by far the greatest number of genera and species in the Ethiopian region, and there can be little doubt that further investigation of the fossil fauna of Africa will disclose the ancestors of the extraordinary bovine antelopes which flourish on that continent.

It is most probable that all the *Bovidae* achieved their development in Africa in Oligocene and Miocene times. They first appeared in Eurasia, in the early Pliocene, became abundant and spread rapidly throughout the continent, reaching North America at a much later period, the Middle Pleistocene. At an early date some members of this family pushed to the far north, and becoming adapted to boreal conditions, produced types like the musk-ox. Others accepted a mountain habitat, and developed the goats, the sheep, and the mountain antelopes, the latter exemplified by the American *Oreamnos*.

## THE DEER.

In contrast to this probable African origin of the *Bovidae*, there is little doubt that the *Cervidae*, or deer family, achieved its development in Eurasia, with an important outlying group on this continent, which, springing from some early Eurasian ancestor, developed into the American deer, *Odocoileus*.

There are in America five genera of this family. The first two, the moose, *Alces*, and the caribou, *Rangifer*, are circumpolar in distribution. Being animals of large size and great endurance, they can and do make long migrations, the moose rarely and only when impelled by danger or failing food supply, and the caribou at regular intervals. It is consequently not surprising to find a close resemblance between the Old and New World species of each genus.

Both the moose and caribou may have developed in some as yet unknown subarctic land. In fact these two genera seem to afford the only evidence from the fauna of North America in support of the theory of the boreal continent. Of the two, the caribou shows, in its structure, more adaptation to Arctic conditions.

Of the American moose only two species are known, one of limited distribution in southern Alaska, *A. gigas*, and the other, *A. americanus*, ranging from the limit of tree growth in western and northern Alaska to Nova Scotia on the Atlantic coast, and just entering the United States at several points along its northern boundary. It is a larger and finer animal than its Eurasian relative. This, too, holds true of the caribou.

We have in the American Pleistocene deposits a mooselike form known as *Cervalces*, with complex antlers which are highly suggestive of those of the giant Alaskan moose. This animal was closely related and possibly ancestral to the moose, in which case the moose may have developed in the northern part of the continent and crossed into Eurasia. More probably it represents another and somewhat aberrant species of moose, coming in at the same time from northern Siberia or other boreal lands.

In the genus *Rangifer* we have a greater variety of types, and the species fall naturally into two groups: barren ground caribou and woodland caribou.

The first has five species: *R. granti*, of the Alaskan Peninsula on the west; *R. stonei*, of the Kenai Peninsula and adjoining mainland (the handsomest of barren ground caribou); the typical *R.*

*arcticus*, of the Barren Grounds; *R. pearyi*, of Ellesmereland, and *R. groenlandicus*, of Greenland.

The second group, of woodland caribou, holds four species, all of which lie to the south of the barren ground species. In contrast to their northern cousins they are forest animals. In the Cassiar Mountains of British Columbia we have *R. osborni*, handsomest and largest of all caribou; *R. montanus*, of British Columbia, passing over the border into the United States; *R. caribou*, of Canada, east into Nova Scotia, and *R. terraenovae*, in Newfoundland.

These nine species are all fairly well separated, and are all, but especially the barren ground group, closely related to the Eurasian reindeer, of which as yet only three species have been described. Their varietal development on this continent indicates a long residence here, longer probably than that of the moose.

The next genus of the deer, *Cervus*, has one outlying member in America, the wapiti. This genus first appears fossil in the Middle Pleistocene, and has only developed two local races of doubtful value, *C. occidentalis*, or the Olympic elk, and *C. merriami*, a small form from Arizona and the San Joaquin Valley in California. The wapiti once ranged to the Atlantic Ocean and as far northeast as the Adirondacks, and in the East may possibly have had local characters of subspecific value.

#### THE AMERICAN DEER.

Last of all the deer we come to a strongly marked genus, *Odocoileus*, which includes all North American deer not referred to above. There are in the United States and Canada at least four well-marked species, with seven or eight subspecies. In South and Central America there are at least twenty additional species, all belonging to *Odocoileus*, together with a closely related genus containing one small and aberrant form, *Pudua*.

All deer being of northern origin, these South American deer show signs of the deterioration which inevitably overtakes the members of the deer family when they enter the tropics.

Only three of the North American species need be referred to: first, the Virginia deer, *O. virginianus*, extending with its subspecies westward into the Rockies and south into Florida and Texas, where it meets the closely related Coues' deer, *O. couesi*; second, the mule deer, *O. hemionus*, of the Western plains and

Rockies; and, third, the Columbia black-tailed deer of the Pacific coast, *O. columbianus*, with its outlying subspecies in the North, the Sitka deer, *O. c. sitkensis*.

The genus *Odocoileus* departs widely from all the Old World types. Its closest allies, as far as foot structure is concerned, are *Alces* and *Rangifer*.

These American deer have been on this continent for a very long time, possibly as far back as the Miocene. They have spread throughout both North and South America, and have developed many well-defined species, both facts indicating a long period of radiation on this continent. The antlers of *Odocoileus* cannot be in any way correlated with those of any other genus of the deer family, least of all with those of *Cervus*.

All the members of the *Cervidae* sprang originally from the same stock, but this ancestral form was either hornless, or else had a simple spike, with, at most, a single branch, resembling the dag-antler of the yearling. This spike-horn ancestor is probably the correct explanation, as otherwise it is necessary to assume that the different members of the deer family acquired the extraordinary character of deciduous antlers independently, and to find a common ancestor we should have to go back to a hornless cervine, resembling the existing musk-deer or the Chinese water deer.

A Miocene group of ruminants found in North America, which has heretofore been considered as possibly ancestral both to *Odocoileus* and *Antilocapra*, proves, on close investigation, to be a new and separate family, or at least a clearly defined subfamily of the *Bovidae*. This group includes *Cosoryx*, *Blastomeryx* and *Merycodus*.

These merycodonts are practically antlered antelopes, being in foot structure, the high molar crowns, and in other characters, close to the bovine antelopes, and still closer to *Antilocapra*, and, were it not for the antlers, they might be considered ancestral to the latter. In this affinity to the prong-horns they suggest an American ancestry for that animal.

*Paleomeryx*, however, is a true deer, and is found both in the American Miocene and in the European Oligocene. It is a generalized cervine. The American forms had unbranched antlers, situated directly over the eye, apparently with permanent velvet, and without a burr, suggesting in these respects the giraffe. The European forms, however, although earlier, were much more specialized, and had both a burr and naked antlers, with a single prong.

The existence of *Paleomeryx* in America proves that as early as the Miocene, deer existed here, which could readily have given rise to *Odocoileus*. This, taken together with the fact that there is no known Old World line which suggests *Odocoileus*, would indicate an American origin for the latter animal. Nevertheless *Odocoileus* is not found fossil earlier than the Middle Pleistocene, when both *O. virginianus* and *O. hemionus* appear at the same time with *Cervus*.

#### THE PRONG-HORN OR AMERICAN ANTELOPE.

Of the prong-horn, *Antilocapra americana*, and its aberrant characters, much could be written. It is not an antelope, not even in the sense that the mountain goat is an antelope, but stands absolutely alone, and represents one of Nature's efforts to evolve a horned animal. It certainly has developed all its peculiar characters on this continent, but has not yet been found fossil earlier than the Lower Pleistocene.

Although the family *Antilocapridae* has but one genus and a single species, with a northern and southern form, yet its characters are so extraordinary that it is properly assigned to a rank of equal value with the *Cervidae* and the *Bovidae*.

The horns of the prong-horn differ greatly from those of the other hollow-horned ruminants, but not so much as do the horns of the latter from the antlers of the deer, but all the structural characters of the prong-horn, other than its exceptional horns, indicate an affinity with the bovine antelopes rather than with the deer.

First we have the peculiarity of the horns being placed directly over the eye, a character which the prong-horn seems to share with the American Miocene antlered antelopes or merycodonts. Next, the horn structure itself is unique. It is not a bony process of the skull, like the antlers of the deer, but grows over a persistent horn-core. It is pronged, and, above all, is annually shed not long after the rutting season.

The horns of the *Bovidae* are a process of the skin, of the same material as hoofs, claws and nails. But the horns of the prong-buck are composed of agglutinated hair, paralleling in this respect the horn of the rhinoceros. However, hair is also an epidermal process, and the horns of the prong-buck are histologically closely related to those of the *Bovidae*.

The horns of other hollow-horned ruminants may be spiral,

lyrate, straight or curved, annulated or studded with bosses, but they can never be forked, and are never deciduous.

Which of these types of horn structure is the most ancient, that of the prong-horn, of the bovines, of the deer, or of the giraffe, we do not know, but the present evidence from paleontology indicates that the lines of descent diverged before horns came into existence.

The giraffe and the kindred okapi form another great group of horned animals, representing an entirely different scheme of structure, the horns being persistent and permanently covered with velvet. It has been suggested that this horn is a mere generalized structure, from which were evolved the antlers of the deer. This theory does not seem well supported by the facts, especially since a new species of giraffe has been recently discovered in Africa with an additional pair of horns, making five in all, the two extra horns being, like the third horn of the common species, quite rudimentary.

The okapi also has two rudimentary horn cores, indicated externally by mere tufts of hair. All these horns are rudimentary and cannot be correlated with the antlers of the deer.

A number of giraffine forms have been found in the Pliocene of Greece and India, and the *Giraffidae* appear to represent a separate line of descent from a hornless ancestor of African antecedents.

Nature made similar experiments in North America with the colossal *Titanotheres*, giving them paired horns on the extreme front of the skull, and with the *Uintatheres*, which had three pairs of horns. These efforts appear to have resulted in failures, since the groups no sooner obtained their full development than they rapidly became extinct.

On the other hand the rhinoceroses, with unpaired horns, set in the median line of the skull, have survived to the present day.

The horns of the giraffe and the bovines are present in both sexes, and are primarily weapons of defense, although the horns of male bovines are larger and stronger than those of the females. The branched and deciduous antlers of the deer and the prong-horn, on the other hand, are confined to the males, practically without exception,\* and being functional only during the mating half of the year, are consequently secondary sexual characters.

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\* The female Caribou has small antlers.

# DERIVATION OF NORTH AMERICAN MAMMALS.

## DIDELPHIDÆ: MARSUPIALS.

*Didelphys*, Opossum .....North American, of great antiquity.

## DASYPODIDÆ: EDENTATES.

*Cabassous*, Armadillo.....South American.

## ERITHIZONTIDÆ: RODENTS.

*Porcupines* .....South American.

HAPLODONTIDÆ: }  
*Sewellel*, } .....North American.

GEOMYIDÆ: }  
 Pouched Rats, }

Other Families.....Eurasian or Cosmopolitan.

## BOVIDÆ: UNGULATES.

*Ovibos*, Musk-Ox, }  
*Bison*, Buffalo, } Eurasian, possibly of remote African  
*Ovis*, Mountain Sheep. } origin.  
*Oreamnos*, Mountain Goat. }

CERVIDÆ:  
*Alces*, Moose, }  
*Rangifer*, Caribou, } .....Boreal or Eurasian.  
*Cervus*, Wapiti .....Eurasian.  
*Odocoileus*, American Deer.....North American.

ANTILOCAPRIDÆ:  
*Antilocapra*, Prong-Horn.....North American.

DICOTYLIDÆ:  
*Dicotyles*, Peccary.....North American.

## URSIDÆ: CARNIVORES.

*Ursus*—Black Bear Group, }  
 Grizzly Bear Group, } Eurasian, probably arriving in the  
 Brown Bear Group. } order named

MUSTELIDÆ:  
*Taxidea*, Badger, }  
*Mephitis*, } Skunks, } .....North American.  
*Spilogale*, }  
*Gulo*, Wolverine, }  
*Mustela*, Marten, }  
*Putorius*, Mink, } .....Eurasian.  
*Lutra*, Otter, }  
*Lutra*, Sea Otter, }

PROCYONIDÆ:  
*Bassariscus*, Cacomistle, }  
*Procyon*, Raccoon, } .....North American.  
*Nasua*, Coati Mundi. }

CANIDÆ:  
*Urocyon*, Gray Fox.....North American, doubtfully.  
*Canis*, Wolf, }  
*Vulpes*, Fox, } .....Eurasian.

FELIDÆ:  
*Lynx*, Lynx.....Eurasian.  
*Felis*, Puma.....Eurasian, probably.

To sum up the contents of the preceding pages we find that we have:

First: The Puerco radiation (in Europe also in part);

Second: The Wasatch or Lower Eocene radiation (in Europe also in part).

In each of these two radiations we have three elements:

a. A fauna found both in America and in Europe;

b. An independent American fauna;

c. An independent Eurasiatic fauna.

Third: A portion of the Second or Wasatch American fauna, by migration into Europe.

Fourth: A portion of the Second or Lower Eocene Eurasiatic fauna, by migration into America.

In Miocene times there also appears an African fauna, a large portion of which enters Europe and Asia, sending into North and South America mastodons, and into North America only mammoths and modified *Bovidae*. In Pliocene times North America receives a South American fauna.

This completes our review of the important mammals of North America.

We find that the great majority of our large animals came recently from Eurasia, but all have been here long enough to develop characters of specific rank.

There is also a native element, which seems to have survived the devastation of the glaciers, including the prong-horn, the American deer, the peccaries, the raccoons and the opossums.

A small South American element, consisting chiefly of the armadillos and the porcupines, of considerable antiquity, can also be traced.

The element of recent arrivals is naturally strongest in the North, and in the Arctic itself we find certain species, like the white bear and the arctic fox, which are circumpolar in their distribution.

In the South the native element and the South American types become more and more prominent as we proceed through the United States and Mexico southward, until at last the face of nature changes, and we find ourselves in the tropics, amid the strange fauna of South America.

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The writer desires to express his deep sense of appreciation of the courtesy and aid in the preparation of the above paper, of Prof. Henry Fairfield Osborn and of Dr. W. D. Matthew, both for their special knowl-



edge of the subjects treated and for the material placed at his disposal by them in the American Museum of Natural History, and also to William T. Hornaday, Director of the New York Zoological Park.

Reference has been had to the following books:

The Geography of Mammals, by W. L. and P. L. Sclater.

Mammals Living and Extinct, by Flower and Lydekker.

Geographic History of Mammals, by Lydekker.

Mammalia, by F. E. Beddard.

Distribution of Animals, by Angelo Heilprin.

Island Life, by Alfred Russel Wallace.

A Synopsis of the Mammals of North America, by Daniel Giraud Elliot.

And especially: The Rise of the Mammalia in North America, The Law of Adaptive Radiation, in American Naturalist, 1902, The Faunal Relations of Europe and America, and Theory of the Successive Invasions of an African Fauna into Europe, New York Academy of Science, 1900, by Henry Fairfield Osborn.

Classification of the Fresh-Water Tertiary, The Merycodus, Field Notes, etc., in the Bulletins of the American Museum of Natural History, by W. D. Matthew.

Polar Climate in Time, by G. R. Wieland, in the American Journal of Science for December, 1903.

Origin of the Primates, by J. L. Wortman, in the American Journal of Science for June, 1903.

BY-LAWS  
OF THE  
**New York Zoological Society**

AMENDED TO FEBRUARY 1, 1903.

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ARTICLE I.

MEETINGS OF THE SOCIETY.

SECTION 1. The office and place of business of the New York Zoological Society shall be in the City of New York, unless otherwise ordered.

SEC. 2. The Society shall hold its annual meeting for the election of Managers, and other business, on the second Tuesday of January, or such day thereafter during the month of January to which said annual meeting shall adjourn.

SEC. 3. Special meetings of the Society shall be called by the Secretary, upon the request of the President or the Chairman of the Executive Committee, or at the written request of ten members.

SEC. 4. Notices of all meetings shall be mailed to each member of the Society at least three days before such meeting.

SEC. 5. At meetings of the Society twenty members shall constitute a quorum.

SEC. 6. The order of business shall be as follows:

1. Roll call.
2. Reading of minutes not previously read.
3. Report of Executive Committee.
4. Report of Secretary.
5. Report of Treasurer.
6. Report of Director of the Zoological Park.
7. Report of Director of the Aquarium.
8. Election of Managers.
9. Communications.
10. Miscellaneous business.
11. Reports and resolutions.

ARTICLE II.

BOARD OF MANAGERS.

SEC. 1. The Board of Managers shall consist of thirty-six members, together with the Mayor of New York and President of the Park Board, or Commissioner for the Bronx, who shall be members *ex-officio* of the Board.

SEC. 2. Nineteen Managers shall constitute a quorum, but ten managers may transact current business, and adjourn, subject to the subsequent approval of a meeting at which a quorum shall be present.

SEC. 3. The Board of Managers shall hold an annual meeting on the third Tuesday of January, or on such day thereafter to which said annual meeting shall adjourn. Regular meetings of the Board may also be called

by the Secretary on the third Tuesdays of October and April, upon the request of the President or Chairman of the Executive Committee. Special meetings of the Board shall be called at any time by the Secretary, upon the request of the President or Chairman of the Executive Committee, or at the written request of five Managers.

SEC. 4. Notices of meetings of the Board shall be mailed to each Manager at least three days before such meetings.

SEC. 5. The successors to the outgoing class of Managers shall be elected by the Society at its annual meeting, but vacancies in the Board may be filled for the unexpired term by the Board of Managers, or by the Executive Committee.

SEC. 6. A Nominating Committee shall be annually appointed by the Executive Committee, and shall consist of three members of the Society at large, who shall nominate and post ten days before the annual election the names of twelve persons to succeed the outgoing class of Managers in a conspicuous place in the office of the Society.

SEC. 7. No person shall be eligible for election to the Board of Managers, except to fill vacancies, unless his name shall have been posted as a candidate by such Committee, or by not less than ten members, in writing, in a conspicuous place in the office of the Society ten days before the annual election. All candidates for election as Managers must be Life Members, Patrons, Associate Founders, or Founders of the Society.

SEC. 8. Any Manager who shall fail to attend three consecutive meetings of the Board, unless excused by vote of the Board, shall cease to be a Manager.

SEC. 9. The Board of Managers shall at its annual meeting elect a President, two Vice-Presidents, a Secretary and a Treasurer, who shall hold office for one year, or until their successors are elected. The President, Vice-Presidents, and Treasurer shall be members of the Board.

SEC. 10. The Director of the Zoological Park, the Director of the Aquarium, and all other persons employed by the Society, shall be appointed by the Board or by the Executive Committee, and shall hold office during the pleasure of the Board.

SEC. 11. The Board shall, at its annual meeting, elect an Executive Committee and Auditing Committee, which shall hold office for one year, or until their successors are elected. The Board of Managers and the Executive Committee shall also have authority to appoint such other Committees or Officers as they may at any time deem desirable, and to delegate to them such powers as may be necessary.

SEC. 12. The order of business of the meetings of the Board shall be as follows:

1. Roll call.
2. Reading of minutes not previously read.
3. Report of Executive Committee.
4. Report of Secretary.
5. Report of Treasurer.
6. Report of Auditing Committee.
7. Report of Directors of the Zoological Park.
8. Report of Director of the Aquarium.
9. Election of Officers.
10. Election of Committees.
11. Election of new members.
12. Communications.
13. Miscellaneous business.

SEC. 13. All reports and resolutions shall be in writing, and the ayes and nays may be called on any resolution at the request of one Manager.

SEC. 14. Whenever the funds of the Society shall permit, the Board of Managers or the Executive Committee may award medals or other prizes for meritorious work connected with the objects of the Society.

## ARTICLE III.

## OFFICERS.

SEC. 1. The officers of the Society shall consist of a President, two Vice-Presidents, a Treasurer, a Secretary and a Director of the Zoological Park. These officers, with the exception of the Director, shall be elected at the annual meeting of the Board of Managers, but any vacancy may be filled for an unexpired term by the Board of Managers, or by the Executive Committee, until the next annual election.

SEC. 2. The President shall preside at all meetings of the Board and of the Society, and shall be *ex-officio* a member of the Executive and Auditing Committees.

SEC. 3. The Vice-Presidents shall, in the absence of the President, perform his duties and possess his powers, acting in the order of their election.

SEC. 4. The Treasurer shall receive, collect and hold, subject to the order of the Board of Managers, or the Executive Committee, all dues, subscriptions, warrants from the City, fees and securities. He shall pay all bills as ordered by the Board of Managers or the Executive Committee, and shall report to the Society at its annual meeting, and to the Board of Managers at all regular meetings and to the Executive Committee at each meeting. He shall keep all moneys and securities in some bank or trust company to be approved by the Board of Managers or Executive Committee. The books of the Society shall at all times be open to the inspection of the Managers.

SEC. 5. The Secretary shall be a salaried officer of the Society. He shall be present, unless otherwise relieved by the Board or Executive Committee, at all meetings of the Society, of the Board and of the Standing Committees. He shall keep a careful record of all proceedings, shall have the custody of the seal, archives and books, other than books of account, and shall conduct the correspondence of the Society. He shall issue all notices and tickets and shall perform such other duties as the Board may direct. He shall be a member *ex-officio* of the Executive, Aquarium and Auditing Committees and of the Scientific Council.

SEC. 6. The Director of the Zoological Park shall be elected annually by the Executive Committee at a salary to be determined by said Committee, and paid monthly from funds of the Society. He shall be the responsible administrative officer of the Park, and shall recommend to the Executive Committee candidates for the various positions in the Park. He shall also perform all such other duties in connection with the business, scientific and literary administration of the Society as may be assigned to him by the Executive Committee.

SEC. 7. The Director of the Aquarium shall be elected annually by the Executive Committee, and shall hold office until removed or his successor is chosen by said Committee. He shall be the responsible administrative officer of the Aquarium, and shall recommend to the Executive Committee all candidates for positions in the Aquarium. The Director of the Aquarium shall be *ex-officio* a member and Chairman of the Aquarium Committee. He shall perform such other duties in connection with the Aquarium as may be assigned to him by the Executive Committee.

## ARTICLE IV.

## COMMITTEES.

SEC. 1. There shall be two standing committees, the Executive Committee and the Auditing Committee, which shall hold office for one year or until their successors are elected.

SEC. 2. The Executive Committee shall consist of seven Managers, together with the President and Secretary of the Society *ex-officio*. Four members shall constitute a quorum, and all meetings shall be called by the Chairman. The Executive Committee shall fill all vacancies in its own number and shall have the full powers of the Board of Managers, except so far as such delegation of power may be contrary to law.

SEC. 3. The Executive Committee shall have the control and regulation of the collections, library and all other property of the Society, and shall have power to purchase, sell and exchange specimens and books, to employ and control all officials and employees of the Society, Park, and Aquarium, and generally to carry out in detail the directions of the Board of Managers and the terms of any contract between the City, or Park Board, and the Society.

SEC. 4. All the rules and regulations for the examination of applicants for the various positions in the Park and Aquarium shall be made or approved by the Executive Committee.

SEC. 5. The Executive Committee may regulate the auditing and payment for all current accounts.

SEC. 6. The Executive Committee shall annually appoint an Aquarium Committee, whose duties and powers are set forth in Section 11 of Article IV. of these By-Laws.

SEC. 7. The Executive Committee shall annually appoint a Nominating Committee, whose duties and powers are set forth in Sections 6 and 7, Article II. of these By-Laws.

SEC. 8. It shall also appoint a Scientific Council, whose powers and duties are set forth in Section 2 of Article V. of these By-Laws.

SEC. 9. The Committee shall make a written report at each regular meeting of the Board of Managers.

SEC. 10. The Auditing Committee shall consist of three regular members of the Society, in addition to the President and Secretary, members *ex-officio*, and vacancies shall be filled by the Executive Committee. It shall be the duty of the Auditing Committee to audit, annually, the accounts of the Treasurer, of the Director of the Zoological Park, and of the Director of the Aquarium, and any other accounts of the Society, and shall report to the Board of Managers at its annual meeting.

SEC. 11. The Executive Committee shall annually appoint an Aquarium Committee of five members of this Society, who shall hold office until their successors are chosen. All vacancies shall be filled by the Executive Committee. The Director of the Aquarium shall be *ex-officio* a member and the Chairman of the Aquarium Committee, and such Committee may vest in him any or all of its powers. The Chairman of the Executive Committee and the Secretary of the Society shall also be *ex-officio* members of the Aquarium Committee. Three members shall constitute a quorum. The Executive Committee may delegate to the Aquarium Committee such powers as it may deem proper.

## ARTICLE V.

### SCIENTIFIC COUNCIL.

SEC. 1. The Executive Committee shall annually appoint a Scientific Council of not more than ten members, and shall fill all vacancies. Members of the Council shall hold office until their successors are appointed.

SEC. 2. The duties of the Council shall be to act as an advisory board in all matters pertaining to the scientific administration of the Society, and especially as to the scientific features of the Park, the promotion of zoology by publications and otherwise, and the preservation of the native fauna of America.

SEC. 3. Four members, including the Chairman, shall constitute a

quorum. The Chairman shall be elected annually by the Council. The Chairman of the Executive Committee and the Secretary of the Society shall be members *ex-officio* of the Council.

## ARTICLE VI.

### MEMBERS.

SEC. 1. The present members and such others as shall become associated with them, under the conditions prescribed by the By-Laws, shall be members of this Society as long as they shall comply with the By-Laws.

SEC. 2. Members failing to comply with these By-Laws, or for other good and sufficient cause, may be expelled from the Society by the Executive Committee.

SEC. 3. Candidates for membership shall be proposed and seconded by members of the Society. The name, occupation and place of residence of every member so proposed shall be submitted for election to the Board of Managers or the Executive Committee, and such person, when elected, shall become a member upon payment of the annual dues, or of the fees as prescribed below.

SEC. 4. The annual dues shall be ten dollars, payable in advance, on the first day of May of each year, but the Executive Committee may remit the dues for the current year in the case of members elected between January 1st and May 1st of each year. The classes of membership shall be as follows:

SEC. 5. The payment of \$200 at one time shall constitute any member a Life Member.

SEC. 6. The payment of \$1,000 at one time, or in the case of a Life Member, of \$800, shall constitute any member a Patron.

SEC. 7. The payment of \$2,500 at one time, or in the case of a Patron of \$1,500, or of a Life Member of \$2,300, shall constitute any member an Associate Founder.

SEC. 8. Any member who shall donate to the Society \$5,000, or property of equal value, or any Associate Founder who shall donate \$2,500, or any Patron who shall donate \$4,000, may be elected by the Board of Managers or Executive Committee a Founder.

SEC. 9. Any member who shall have donated to the Society ten thousand dollars (\$10,000), or its equivalent, may be elected by the Board of Managers or the Executive Committee a Founder in Perpetuity. Such Founder in Perpetuity shall have the power to designate by a last will and testament his successor, who shall thereupon be entitled to all the rights and privileges of the original Founder in Perpetuity, including the right of designating in turn his successor.

SEC. 10. Any member who shall donate to the Society \$25,000, or any Founder who shall donate \$20,000, may be elected by the Board of Managers or Executive Committee a Benefactor. A Benefactor shall have all the rights and privileges of a Founder in Perpetuity.

SEC. 11. Persons who have rendered marked service in the science of zoology or natural history may be elected Honorary Members, but not more than three such Honorary Members shall be elected in any one calendar year.

SEC. 12. A resident member who shall have rendered marked scientific or professional services to the Society in any branch of its work may be elected by the Executive Committee a Life Member, Patron, Associate Founder, or Founder. A resident of New York who shall have rendered marked services in zoology or natural history may be elected by the Executive Committee a Permanent Fellow.

SEC. 13. Non-residents who communicate valuable information to the Society, or who have rendered marked service in the science of zoology or natural history, may be elected Corresponding Members.

SEC. 14. Benefactors, Founders in Perpetuity, Founders, Associate Founders, Patrons, Life Members, Honorary Members, Permanent Fellows and Corresponding Members shall be exempt from annual due.

## ARTICLE VII.

### PRIVILEGES OF MEMBERS.

SEC. 1. A member's ticket admits the member and his immediate family to the Park on reserve days, and to all lectures and special exhibitions, and may be used by the member's immediate family, and shall be good for the current year.

SEC. 2. Admission tickets to the Park and Aquarium on reserve days are issued to members for distribution, and are good for the current year.

SEC. 3. Each member of the Society is entitled annually to a member's ticket and to ten admission tickets.

SEC. 4. Each member shall also receive one copy of the catalogue or handbook, the report and official publications of the Society, and shall have all the privileges of the Library and Members' Building.

SEC. 5. No member shall be entitled to the privileges enumerated in this Article unless his annual dues shall have been paid.

SEC. 6. The Life Members shall have all the privileges of Members and ten additional admission tickets.

SEC. 7. Benefactors, Founders in Perpetuity, Founders, Associate Founders and Patrons shall have all the privileges of Life Members, and shall in addition receive copies of all scientific works published by the Society.

SEC. 8. Any member who shall fail to pay his annual dues within three months after the same shall have become due, and after notice of thirty days, by mail, shall cease to be a member of the Society; subject, however, to reinstatement by the Board of Managers or Executive Committee for good cause shown.

SEC. 9. Any person elected to membership who shall fail to qualify within three months after notice of his election shall be considered to have declined his election; but such term may be extended by the Board of Managers or Executive Committee.

## ARTICLE VIII.

### FINANCES.

SEC. 1. The fiscal year of the corporation shall be the calendar year commencing January 1st and ending December 31st.

SEC. 2. Neither the Society nor any of its Managers or Officers shall contract any debt which, with existing debts, shall exceed in amount the funds then in the Treasury, except to meet expenditures for which the city is liable, and for which the Society will be reimbursed by warrants from the Comptroller's office.

## ARTICLE IX.

### AMENDMENTS.

SEC. 1. Amendments to these By-Laws may be proposed, in writing, at any meeting of the Board of Managers, and adopted by unanimous consent of the Managers present, or if such proposed amendment shall fail to receive unanimous consent, the Secretary shall, with the notices of the next meeting, send a copy of it to each Manager and state that it will be brought up for action at such meeting, when it may be passed by a majority vote.

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