



ASTRONAUT
JESSICA MEIR

THE
NATURE
OF
EXPLORATION

1
00:00:01,334 --> 00:00:07,807
[MUSIC]

2
00:00:08,742 --> 00:00:09,576
>> BIOLOGY WAS ALWAYS

3
00:00:09,576 --> 00:00:11,378
MY FAVORITE SUBJECT GROWING UP.

4
00:00:11,378 --> 00:00:12,512
I'M NOT SURE EXACTLY WHY.

5
00:00:12,512 --> 00:00:13,880
MAYBE IT WAS JUST BECAUSE OF

6
00:00:13,880 --> 00:00:15,682
THIS INHERENT CONNECTION

7
00:00:15,682 --> 00:00:17,117
AND INTEREST IN NATURE.

8
00:00:17,117 --> 00:00:18,351
MAYBE THAT CAME FROM MY MOM.

9
00:00:18,351 --> 00:00:19,219
MAYBE THAT CAME FROM WHERE

10
00:00:19,219 --> 00:00:20,286
I GREW UP, BUT I JUST ALWAYS

11
00:00:20,286 --> 00:00:22,789
LOVED BIOLOGY CLASS.

12
00:00:22,789 --> 00:00:23,690
I WENT TO THE ANTARCTIC

13
00:00:23,690 --> 00:00:24,591

FIVE TIMES.

14

00:00:24,591 --> 00:00:25,992

FOUR TIMES WAS FOR

15

00:00:25,992 --> 00:00:27,927

MY PHD RESEARCH.

16

00:00:27,927 --> 00:00:29,028

I WAS WORKING AT THE SCRIPPS

17

00:00:29,028 --> 00:00:30,397

INSTITUTION OF OCEANOGRAPHY,

18

00:00:30,397 --> 00:00:32,232

WHICH IS PART OF U.C. SAN DIEGO.

19

00:00:32,232 --> 00:00:33,066

WE WERE LOOKING AT

20

00:00:33,066 --> 00:00:34,467

THE DIVING PHYSIOLOGY OF ANIMALS

21

00:00:34,467 --> 00:00:35,502

IN GENERAL.

22

00:00:35,502 --> 00:00:36,102

AND THE WORK THAT

23

00:00:36,102 --> 00:00:37,070

WE WERE PURSUING THEN

24

00:00:37,070 --> 00:00:38,037

IN THE ANTARCTIC

25

00:00:38,037 --> 00:00:39,339

WAS LOOKING AT THE DIVING

26
00:00:39,339 --> 00:00:41,174
PHYSIOLOGY OF EMPEROR PENGUINS.

27
00:00:44,511 --> 00:00:51,351
[MUSIC]

28
00:00:51,351 --> 00:00:52,419
HOW THEY COULD SUPPORT THIS

29
00:00:52,419 --> 00:00:54,053
EXTRAORDINARY BEHAVIOR--

30
00:00:54,053 --> 00:00:56,423
DIVING DEEPER THAN 500 METERS

31
00:00:56,423 --> 00:00:57,257
AND FOR LONGER THAN

32
00:00:57,257 --> 00:00:59,459
HALF AN HOUR ON A SINGLE BREATH.

33
00:00:59,459 --> 00:01:00,627
WE PUT PHYSIOLOGICAL DATA

34
00:01:00,627 --> 00:01:02,128
RECORDERS ON THE ANIMALS.

35
00:01:02,128 --> 00:01:03,296
I WAS EVEN FORTUNATE ENOUGH

36
00:01:03,296 --> 00:01:04,497
TO DIVE WHERE WE WERE DOING

37
00:01:04,497 --> 00:01:05,932
OUR RESEARCH WITH PENGUINS.

38
00:01:05,932 --> 00:01:07,066

SO EMPEROR PENGUINS

39

00:01:07,066 --> 00:01:08,535
WHIZZING AROUND YOU,

40

00:01:08,535 --> 00:01:09,335
YOU CAN IMAGINE WHAT AN

41

00:01:09,335 --> 00:01:11,204
EXTRAORDINARY FEELING THAT IS.

42

00:01:11,204 --> 00:01:13,072
AND IT WAS JUST COMPLETELY

43

00:01:13,072 --> 00:01:14,574
EYE-OPENING.

44

00:01:14,574 --> 00:01:15,542
AND WE DID MEASURE

45

00:01:15,542 --> 00:01:16,409
HEART RATES AS LOW AS

46

00:01:16,409 --> 00:01:17,477
THREE BEATS PER MINUTE

47

00:01:17,477 --> 00:01:18,344
AND DOWN AROUND

48

00:01:18,344 --> 00:01:19,579
FIVE TO SIX BEATS PER MINUTE

49

00:01:19,579 --> 00:01:21,481
FOR A WHOLE FIVE MINUTE PERIOD.

50

00:01:21,481 --> 00:01:22,715
SO THAT'S REALLY EXTRAORDINARY

51
00:01:22,715 --> 00:01:23,783
IF YOU THINK ABOUT

52
00:01:23,783 --> 00:01:24,984
COMPARING THAT TO

53
00:01:24,984 --> 00:01:26,119
AN EXERCISING HUMAN

54
00:01:26,119 --> 00:01:27,554
OR ANY ANIMAL EXERCISING

55
00:01:27,554 --> 00:01:28,988
ON THE SURFACE OF THE EARTH

56
00:01:28,988 --> 00:01:30,123
WHERE YOU KNOW YOU HAVE

57
00:01:30,123 --> 00:01:30,957
THIS CHARACTERISTIC

58
00:01:30,957 --> 00:01:31,991
EXERCISE RESPONSE.

59
00:01:31,991 --> 00:01:33,226
YOUR HEART RATE INCREASES

60
00:01:33,226 --> 00:01:34,260
TO GET MORE OXYGEN

61
00:01:34,260 --> 00:01:35,295
AND BLOOD FLOW TO ALL OF

62
00:01:35,295 --> 00:01:36,396
THE EXERCISING TISSUES

63
00:01:36,396 --> 00:01:37,464

AND MUSCLES.

64

00:01:37,464 --> 00:01:38,131
SO THESE ANIMALS

65

00:01:38,131 --> 00:01:39,065
ARE DOWN THERE.

66

00:01:39,065 --> 00:01:40,033
THEY'RE ALSO EXERCISING.

67

00:01:40,033 --> 00:01:41,034
THEY'RE SWIMMING AROUND,

68

00:01:41,034 --> 00:01:42,035
THEY'RE CATCHING FISH,

69

00:01:42,035 --> 00:01:43,369
THEY'RE FORAGING.

70

00:01:43,369 --> 00:01:44,404
AND THEY'RE DOING THAT

71

00:01:44,404 --> 00:01:45,805
WHILE LOWERING THEIR HEART RATE.

72

00:01:45,805 --> 00:01:47,040
SO IT'S THIS REALLY UNIQUE

73

00:01:47,040 --> 00:01:48,274
DIVE RESPONSE.

74

00:01:50,777 --> 00:01:51,744
SO FOR MY POST-DOCTORAL

75

00:01:51,744 --> 00:01:53,313
RESEARCH PROJECT, I KIND OF

76
00:01:53,313 --> 00:01:55,248
WENT TO A DIFFERENT EXTREME.

77
00:01:55,248 --> 00:01:56,282
I BECAME VERY INTERESTED

78
00:01:56,282 --> 00:01:57,617
IN THE BAR-HEADED GOOSE,

79
00:01:57,617 --> 00:01:59,252
WHICH IS THE SPECIES OF GOOSE

80
00:01:59,252 --> 00:02:00,653
THAT MIGRATES TWICE A YEAR

81
00:02:00,653 --> 00:02:01,688
OVER THE TALLEST MOUNTAINS

82
00:02:01,688 --> 00:02:02,355
ON THE PLANET.

83
00:02:02,355 --> 00:02:03,756
SO OVER THE HIMALAYAS.

84
00:02:03,756 --> 00:02:04,257
YOU KNOW, IF SOMEBODY IS

85
00:02:04,257 --> 00:02:06,092
THINKING ABOUT CLIMBING EVEREST,

86
00:02:06,092 --> 00:02:07,594
THEN THEY GO WEEKS IN ADVANCE,

87
00:02:07,594 --> 00:02:08,695
THEY GO TO BASE CAMP,

88
00:02:08,695 --> 00:02:09,429

THEY ALLOW THEMSELVES

89

00:02:09,429 --> 00:02:10,497

TO ACCLIMATE THEIR

90

00:02:10,497 --> 00:02:11,564

PHYSIOLOGICAL PROCESSES

91

00:02:11,564 --> 00:02:12,665

CATCH UP A LITTLE BIT--

92

00:02:12,665 --> 00:02:13,566

GET SOME MORE

93

00:02:13,566 --> 00:02:15,034

RED BLOOD CELLS ONBOARD.

94

00:02:15,034 --> 00:02:16,436

THESE BIRDS ARE DOING THAT

95

00:02:16,436 --> 00:02:17,337

CROSSING FROM--

96

00:02:17,337 --> 00:02:18,538

IN SEVEN TO EIGHT HOURS.

97

00:02:18,538 --> 00:02:20,273

THEY NEED FAR MORE OXYGEN

98

00:02:20,273 --> 00:02:22,108

IN ORDER TO SUPPORT THEMSELVES

99

00:02:22,108 --> 00:02:22,909

WHILE THEY'RE FLYING

100

00:02:22,909 --> 00:02:23,843

THAN THEY WOULD IF THEY WERE

101
00:02:23,843 --> 00:02:24,911
WALKING OR DOWN HERE AT

102
00:02:24,911 --> 00:02:25,712
SEA LEVEL-- BUT THEY'RE

103
00:02:25,712 --> 00:02:27,180
DOING THAT IN AN ENVIRONMENT

104
00:02:27,180 --> 00:02:29,048
THAT HAS AN OXYGEN LIMITATION.

105
00:02:29,048 --> 00:02:31,084
SO HOW ARE THEY DOING THAT?

106
00:02:31,084 --> 00:02:32,952
WE DECIDED TO TRY AND LOOK

107
00:02:32,952 --> 00:02:34,587
AT THIS PROBLEM BY TRAINING

108
00:02:34,587 --> 00:02:35,655
BAR-HEADED GEESE TO FLY

109
00:02:35,655 --> 00:02:36,823
IN A WIND TUNNEL.

110
00:02:36,823 --> 00:02:38,358
AND IN ORDER TO MAKE SURE

111
00:02:38,358 --> 00:02:39,392
THAT THE BIRDS WOULD BE

112
00:02:39,392 --> 00:02:41,561
COMFORTABLE WITH ME AND MY TEAM,

113
00:02:41,561 --> 00:02:43,096

WE IMPRINTED THE ANIMALS.

114

00:02:43,096 --> 00:02:44,564

IT'S PARTICULARLY STRONG

115

00:02:44,564 --> 00:02:45,431

IN WATER FOWL.

116

00:02:45,431 --> 00:02:46,399

SO THE FIRST THING

117

00:02:46,399 --> 00:02:48,167

THAT A DUCK OR A GOOSE SEES

118

00:02:48,167 --> 00:02:49,903

AFTER THEY HATCH, THEY LOOK AT

119

00:02:49,903 --> 00:02:51,504

AS THEIR PARENTAL FIGURE

120

00:02:51,504 --> 00:02:52,839

AND THEY IMPRINT.

121

00:02:52,839 --> 00:02:55,375

SO I GOT SOME EGGS AND I HAD

122

00:02:55,375 --> 00:02:56,643

THE BIRDS IMPRINT ON ME.

123

00:02:56,643 --> 00:02:57,577

SO I WAS THERE FROM THE TIME

124

00:02:57,577 --> 00:02:58,711

THAT THEY HATCHED, YOU KNOW,

125

00:02:58,711 --> 00:02:59,846

THEY WOULD BE HATCHING

126
00:02:59,846 --> 00:03:01,347
IN MY HANDS, COMING OUT OF

127
00:03:01,347 --> 00:03:02,348
THE EGG AND I WAS

128
00:03:02,348 --> 00:03:03,616
THE FIRST THING THEY SAW.

129
00:03:03,616 --> 00:03:04,984
SO THEY THOUGHT THAT I WAS

130
00:03:04,984 --> 00:03:06,052
THEIR MOM AND I WAS

131
00:03:06,052 --> 00:03:07,854
A MODERN DAY MOTHER GOOSE.

132
00:03:07,854 --> 00:03:09,055
I HAD 12 GOSLINGS

133
00:03:09,055 --> 00:03:10,390
THAT WERE FOLLOWING ME AROUND

134
00:03:10,390 --> 00:03:11,758
EVERYWHERE I WENT.

135
00:03:11,758 --> 00:03:13,626
THEY LOOK TO YOU FOR EVERYTHING.

136
00:03:13,626 --> 00:03:14,694
YOU'RE GOING ON WALKS,

137
00:03:14,694 --> 00:03:15,628
YOU'RE CUDDLING WITH THEM,

138
00:03:15,628 --> 00:03:16,596

TAKING NAPS.

139

00:03:16,596 --> 00:03:17,263

IT WAS REALLY AN

140

00:03:17,263 --> 00:03:18,298

EXTRAORDINARY EXPERIENCE

141

00:03:18,298 --> 00:03:19,132

TO HAVE THAT CONNECTION

142

00:03:19,132 --> 00:03:20,366

WITH AN ANIMAL.

143

00:03:20,366 --> 00:03:21,634

AND THEY GROW QUITE QUICKLY.

144

00:03:21,634 --> 00:03:22,335

WITHIN A FEW MONTHS,

145

00:03:22,335 --> 00:03:25,471

THEY HAD FULLY GROWN WINGS.

146

00:03:25,471 --> 00:03:26,606

AND SO WE BROUGHT THE BIRDS

147

00:03:26,606 --> 00:03:27,540

BACK TO THE UNIVERSITY

148

00:03:27,540 --> 00:03:29,208

OF BRITISH COLUMBIA,

149

00:03:29,208 --> 00:03:29,976

AND STARTED TRAINING THEM

150

00:03:29,976 --> 00:03:31,311

TO FLY IN THE WIND TUNNEL.

151
00:03:31,311 --> 00:03:32,211
AND WE OUTFITTED THEM

152
00:03:32,211 --> 00:03:33,880
WITH PHYSIOLOGICAL RECORDERS.

153
00:03:33,880 --> 00:03:34,981
LITTLE BACKPACK RECORDERS

154
00:03:34,981 --> 00:03:36,082
TO MEASURE HEART RATE

155
00:03:36,082 --> 00:03:37,750
AND THEN AGAIN OXYGEN LEVEL.

156
00:03:37,750 --> 00:03:38,451
AND THEN THEY ALSO

157
00:03:38,451 --> 00:03:39,852
WERE OUTFITTED WITH A MASK.

158
00:03:39,852 --> 00:03:41,321
SO, A REALLY LIGHTWEIGHT MASK

159
00:03:41,321 --> 00:03:42,055
THAT WE MADE OUT OF

160
00:03:42,055 --> 00:03:43,590
A DENTAL MOLD MATERIAL.

161
00:03:43,590 --> 00:03:44,524
AND THAT ALLOWED US

162
00:03:44,524 --> 00:03:45,792
TO COLLECT THE AIR

163
00:03:45,792 --> 00:03:47,193

THAT THEY EXHALED

164

00:03:47,193 --> 00:03:48,428

AND THEN THROUGH THAT MASK

165

00:03:48,428 --> 00:03:49,796

WE COULD ALSO CHANGE

166

00:03:49,796 --> 00:03:50,663

THE AMOUNT OF OXYGEN

167

00:03:50,663 --> 00:03:51,831

THAT THEY WERE BREATHING IN.

168

00:03:51,831 --> 00:03:52,732

SO THERE WAS A TUBE WHERE

169

00:03:52,732 --> 00:03:53,733

WE WOULD FLOW NITROGEN INTO

170

00:03:53,733 --> 00:03:55,835

THE MASK AND BASICALLY DECREASE

171

00:03:55,835 --> 00:03:57,070

THE OVERALL OXYGEN LEVELS,

172

00:03:57,070 --> 00:03:58,037

SO THAT WE COULD

173

00:03:58,037 --> 00:03:58,838

SIMULATE ALTITUDE.

174

00:03:58,838 --> 00:04:00,573

SO WE WERE FLYING THESE BIRDS

175

00:04:00,573 --> 00:04:02,375

AT ABOUT HALF TO A THIRD

176

00:04:02,375 --> 00:04:03,376
OF THE AMOUNT OF OXYGEN

177

00:04:03,376 --> 00:04:04,644
THAT WE HAVE AT SEA LEVEL.

178

00:04:04,644 --> 00:04:05,511
A THIRD OF THE AMOUNT

179

00:04:05,511 --> 00:04:06,679
OF OXYGEN IS EQUIVALENT

180

00:04:06,679 --> 00:04:08,014
TO HIGHER THAN THE SUMMIT

181

00:04:08,014 --> 00:04:08,948
OF MOUNT EVEREST.

182

00:04:08,948 --> 00:04:09,716
SO HIGHER THAN

183

00:04:09,716 --> 00:04:11,050
THAT TALLEST PEAK.

184

00:04:11,050 --> 00:04:12,719
AND INTERESTINGLY,

185

00:04:12,719 --> 00:04:13,686
AS WE PREDICTED,

186

00:04:13,686 --> 00:04:15,021
THE BIRDS COULD STILL FLY.

187

00:04:15,021 --> 00:04:15,989
AND IT REALLY ISN'T

188

00:04:15,989 --> 00:04:17,190

JUST ONE ADAPTATION.

189

00:04:17,190 --> 00:04:18,291

THERE IS REALLY A HOST

190

00:04:18,291 --> 00:04:19,926

OF ADAPTATIONS ALL THE WAY

191

00:04:19,926 --> 00:04:20,593

THROUGH WHAT WE CALL

192

00:04:20,593 --> 00:04:21,995

THE OXYGEN TRANSPORT CASCADE.

193

00:04:21,995 --> 00:04:23,663

SO, EVERYTHING FROM

194

00:04:23,663 --> 00:04:25,298

GETTING THE OXYGEN FROM THE AIR,

195

00:04:25,298 --> 00:04:26,265

INTO THEIR LUNGS.

196

00:04:26,265 --> 00:04:27,467

GETTING IT INTO THEIR BLOOD,

197

00:04:27,467 --> 00:04:28,301

GETTING IT DOWN TO

198

00:04:28,301 --> 00:04:29,302

THE INDIVIDUAL CELLS

199

00:04:29,302 --> 00:04:31,004

AND INTO THE MITOCHONDRIA,

200

00:04:31,004 --> 00:04:32,071

WHICH ARE THE POWERHOUSES

201
00:04:32,071 --> 00:04:32,772
OF THE CELLS.

202
00:04:32,772 --> 00:04:34,007
SO THEY REALLY HAVE ADAPTATIONS

203
00:04:34,007 --> 00:04:35,675
AT EVERY STEP OF THE WAY.

204
00:04:38,745 --> 00:04:48,454
[MUSIC]

205
00:04:48,454 --> 00:04:49,589
SO BEFORE I WAS AN ASTRONAUT

206
00:04:49,589 --> 00:04:50,456
AND ACTUALLY EVEN BEFORE

207
00:04:50,456 --> 00:04:51,791
I WENT TO GRADUATE SCHOOL,

208
00:04:51,791 --> 00:04:52,725
I WORKED HERE AT THE JOHNSON

209
00:04:52,725 --> 00:04:53,926
SPACE CENTER FOR THREE YEARS

210
00:04:53,926 --> 00:04:55,695
FOR THE HUMAN RESEARCH FACILITY.

211
00:04:55,695 --> 00:04:56,729
SO OUR GROUP,

212
00:04:56,729 --> 00:04:58,364
WE WERE COORDINATING ALL OF

213
00:04:58,364 --> 00:04:59,666

THE LIFE SCIENCE EXPERIMENTS

214

00:04:59,666 --> 00:05:00,933

THAT WERE CONDUCTED BACK THEN

215

00:05:00,933 --> 00:05:02,135

ON THE SPACE SHUTTLE, AND THEN

216

00:05:02,135 --> 00:05:04,103

ALSO ON THE SPACE STATION.

217

00:05:04,103 --> 00:05:05,338

AND I FIND THAT A REALLY

218

00:05:05,338 --> 00:05:07,106

INTERESTING CONNECTION NOW

219

00:05:07,106 --> 00:05:08,374

BECAUSE FIRST I WAS

220

00:05:08,374 --> 00:05:09,509

COORDINATING THAT KIND OF

221

00:05:09,509 --> 00:05:12,545

SCIENCE ON OTHER ASTRONAUTS.

222

00:05:12,545 --> 00:05:14,013

SECONDLY, I WAS DOING

223

00:05:14,013 --> 00:05:15,014

ALL THESE EXPERIMENTS ON

224

00:05:15,014 --> 00:05:16,215

ALL THESE DIFFERENT ANIMALS.

225

00:05:16,215 --> 00:05:17,116

USING THE ANIMALS AS

226

00:05:17,116 --> 00:05:17,717

THE SUBJECTS,

227

00:05:17,717 --> 00:05:19,218

AND I WAS THE EXPERIMENTER.

228

00:05:22,288 --> 00:05:22,889

AND FINALLY

229

00:05:22,889 --> 00:05:23,990

IT'S COME FULL CIRCLE,

230

00:05:23,990 --> 00:05:25,191

WHERE I WILL BE THE ONE

231

00:05:25,191 --> 00:05:28,728

THAT'S EXPERIMENTED UPON.

232

00:05:28,728 --> 00:05:30,396

AND THESE TYPES OF EXPERIMENTS,

233

00:05:30,396 --> 00:05:31,431

THESE PHYSIOLOGICAL

234

00:05:31,431 --> 00:05:32,565

AND MEDICAL EXPERIMENTS

235

00:05:32,565 --> 00:05:34,600

ARE REALLY IMPORTANT FOR US

236

00:05:34,600 --> 00:05:36,069

IN TERMS OF UNDERSTANDING

237

00:05:36,069 --> 00:05:37,136

ALL OF THE EFFECTS

238

00:05:37,136 --> 00:05:38,371

OF MICROGRAVITY

239

00:05:38,371 --> 00:05:39,639

AND THE SPACEFLIGHT ENVIRONMENT

240

00:05:39,639 --> 00:05:41,741

ON THE HUMAN BODY.

241

00:05:41,741 --> 00:05:42,942

AND THIS WILL BE EVEN MORE

242

00:05:42,942 --> 00:05:44,310

IMPORTANT AS WE BEGIN

243

00:05:44,310 --> 00:05:46,212

TO UNDERTAKE LONGER MISSIONS

244

00:05:46,212 --> 00:05:47,680

WHEN WE GO BACK TO THE MOON

245

00:05:47,680 --> 00:05:49,515

AND EVENTUALLY GO TO MARS.

246

00:05:49,515 --> 00:05:50,750

YOU KNOW, WITH ARTEMIS PROGRAM,

247

00:05:50,750 --> 00:05:51,551

WE ARE PLANNING

248

00:05:51,551 --> 00:05:52,819

THOSE MISSIONS NOW.

249

00:05:52,819 --> 00:05:53,953

AND IT WILL BE EVEN MORE

250

00:05:53,953 --> 00:05:54,954

IMPORTANT FOR US TO MAKE SURE

251
00:05:54,954 --> 00:05:57,090
THAT WE CAN DELIVER ASTRONAUTS

252
00:05:57,090 --> 00:05:58,157
EFFECTIVELY

253
00:05:58,157 --> 00:05:59,559
AND THEY'RE ABLE TO FUNCTION

254
00:05:59,559 --> 00:06:00,893
AT THEIR DESTINATIONS.

255
00:06:00,893 --> 00:06:01,828
AND TO MAKE SURE THAT WE CAN

256
00:06:01,828 --> 00:06:03,629
GET THEM HOME SAFELY AS WELL.

257
00:06:03,629 --> 00:06:04,997
SO BY UNDERSTANDING

258
00:06:04,997 --> 00:06:06,232
ALL THESE PROCESSES WITH

259
00:06:06,232 --> 00:06:07,700
THE DECADES OF RESEARCH

260
00:06:07,700 --> 00:06:08,367
WE HAVE NOW ON THE

261
00:06:08,367 --> 00:06:09,769
INTERNATIONAL SPACE STATION,

262
00:06:09,769 --> 00:06:11,270
WE CAN CONQUER AND APPLY THAT

263
00:06:11,270 --> 00:06:12,672

TOWARD THESE FUTURE FLIGHTS.

264

00:06:21,614 --> 00:06:22,782

I'M JESSICA MEIR.

265

00:06:22,782 --> 00:06:23,649

I'M A SCIENTIST